

COMPOSITE RESIN COMPOSITION FOR ELECTRONIC COMPONENT AND
ELECTRONIC COMPONENT MOLDED FROM COMPOSITE RESIN COMPOSITION

TECHNICAL FIELD

The present invention relates to a composite resin composition for an electronic component and an electronic component molded from the composite resin composition. In particular, the present invention relates to a composite resin composition for an asymmetric electronic component, an asymmetric electronic component molded from the composite resin composition, a composite resin composition for a low-profile narrow-pitch connector, and a low-profile narrow-pitch connector molded from the composite resin composition.

BACKGROUND ART

Liquid crystal polymers are thermoplastic resins having, for example, high dimensional accuracy and excellent fluidity. Because of such characteristics, the liquid crystal polymers have been conventionally used as materials for various electronic components. Liquid crystal polymer compositions for producing electronic components are required to have excellent fluidity. Examples of such electronic components include asymmetric electronic components, low-profile narrow-pitch connectors, and coaxial connectors.

In particular, asymmetric electronic components have the following backgrounds. Due to demands in the present age associated with improvement in performance of electronic

equipment in recent years, i.e., demands for connectors to be more heat resistant (for an increase in productivity by developing mounting technology), more dense (for employment of multi-core), and smaller in size, liquid crystal polymer components utilizing the above-described characteristics of liquid crystal polymers and reinforced with glass fiber have been used as connector materials.

Recently, however, connectors have been further miniaturized, which causes a lack of rigidity due to the insufficient thickness of a molded article or internal stress due to insertion of a metal terminal. As a result, warping deformation occurs after molding or during reflow heating, which causes a problem of defects in soldering with a board. That is, in the conventional reinforcement with only glass fiber, an increase in the amount of glass fiber for increasing rigidity prevents the thin-walled portion from being filled with a resin or causes a problem of deformation of an insert terminal due to the pressure during molding.

In order to solve the problem of warping deformation, the procedure of molding has been devised, and blending of a specific plate-like filler has been proposed from a material aspect. That is, in the case of ordinary connectors (electronic components) widely distributed in the market, the dimensional accuracy and warp of a product can be controlled only by adjusting the gate position and design so as to maintain symmetry when molding. Furthermore, a product with less warping deformation can be prepared by using a

conventionally proposed low-warping material.

However, asymmetric electronic components not having symmetry with respect to any of the XY, YZ, and XZ axial planes of the molded article have been required in association with the complication in the shape of electronic components in recent years. A typical example of the asymmetric electronic component is a memory module connector having a latch structure (having hooks for fixing at both ends), such as a DDR-DIMM connector. In particular, a memory module connector for a notebook computer has a latch structure for installation and also has notches for alignment. The connector therefore has a highly complicated shape.

Such asymmetric electronic components not having symmetry have a limitation in reduction of warping deformation from the aspect of the molding procedure, unlike ordinary connectors (symmetric electronic components) having symmetry with respect to any of the XY, YZ, and XZ axial planes of the molded article. In a case of an asymmetric electronic component having a complicated shape, the orientation of the resin and the filler in a molded article is complicated, higher fluidity is needed, and inhibition of warping deformation is more difficult.

As technologies for solving these problems, for example, Patent Document 1 discloses an asymmetric electronic component not having symmetry with respect to any of the XY, YZ, and XZ axial planes of the molded article molded from a liquid crystal polymer composition including a specific fibrous

filler and a specific plate-like filler at a specific blending ratio.

Incidentally, the low-profile narrow-pitch connectors particularly have the following backgrounds. Electronic components (such as connectors) constituting electronic equipment are required to be reduced in profile and pitch, in association with recent reductions in size and thickness of electronic equipment. Patent Document 2 discloses a connector molded from a liquid crystal polymer composition reinforced with mica and glass fiber. Such a connector is used, for example, as a board to board connector or a flexible printed board connector for connecting between a flexible printed circuit (FPC) and a flexible flat cable (FFC), requiring, for example, fluidity and size stability.

Patent Document 1: PCT International Publication No.
WO2008/023839

Patent Document 2: Japanese Unexamined Patent Application,
Publication No. 2006-37061

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

Unfortunately, known liquid crystal polymer compositions have insufficient fluidity. In particular, it was revealed that some of the known liquid crystal polymer compositions, such as those disclosed in Patent Document 1, cannot be applied to asymmetric electronic components because of changes in shape associated with, for example, a recent increase in

the accumulation rate of asymmetric electronic components, in particular due to factors such as a decrease in pitch distance, a decrease in product height, and an increase in pole number. That is, conventional liquid crystal polymer compositions have insufficient fluidity, and asymmetric electronic components having reduced warping deformation are difficult to be molded from such liquid crystal polymer compositions. Furthermore, in particular, conventionally known liquid crystal polymer compositions have insufficient fluidity and poor workability for molding low-profile narrow-pitch connectors. Therefore, production of low-profile narrow-pitch connectors corresponding to needs for reductions in profile and pitch is difficult.

The present invention has been made in view of the foregoing circumstances, and an object of the invention is to provide a composite resin composition for an electronic component having excellent fluidity and to provide an electronic component molded from the composite resin composition. It is an object of the present invention, in a preferred embodiment, to provide a composite resin composition for an electronic component having excellent fluidity and capable of producing an asymmetric electronic component having reduced warping deformation, and to provide an asymmetric electronic component molded from the composite resin composition. It is an object of the present invention, in a preferred embodiment, to provide a composite resin composition having excellent fluidity and allowing production of a low-

profile narrow-pitch connector and to provide a low-profile narrow-pitch connector molded from the composite resin composition.

Means for Solving the Problems

The present inventors have found that the above-mentioned problems can be solved by combining a liquid crystal polymer containing predetermined amounts of specific constitutional units, a glass fiber and/or milled fiber, and a plate-like inorganic filler. Specifically, the present invention provides the following:

(1) A composite resin composition for an electronic component, the composition comprising a liquid crystal polymer (A), a milled fiber (B), and a plate-like inorganic filler (C); wherein

the liquid crystal polymer (A) includes a constitutional unit (I) derived from 4-hydroxybenzoic acid, a constitutional unit (II) derived from 2-hydroxy-6-naphthoic acid, a constitutional unit (III) derived from terephthalic acid, a constitutional unit (IV) derived from isophthalic acid, and constitutional unit (V) derived from 4,4'-dihydroxybiphenyl, as essential components;

the constitutional unit (I) has a content of 35 to 75 mol% based on the total amount of all of the constitutional units;

the constitutional unit (II) has a content of 2 to 8 mol% based on the total amount of all of the constitutional units;

the constitutional unit (III) has a content of 4.5 to

30.5 mol% based on the total amount of all of the constitutional units;

the constitutional unit (IV) has a content of 2 to 8 mol% based on the total amount of all of the constitutional units;

the constitutional unit (V) has a content of 12.5 to 32.5 mol% based on the total amount of all of the constitutional units;

the sum of the contents of the constitutional units (II) and (IV) is 4 to 10 mol% based on the total amount of all of the constitutional units;

the liquid crystal polymer (A) has a content of 40 to 80 mass% based on the total amount of the composite resin composition;

the milled fiber (B) has a content of 10 to 30 mass% based on the total amount of the composite resin composition; and

the plate-like inorganic filler (C) has a content of 10 to 35 mass% based on the total amount of the composite resin composition;

(2) The composite resin composition for an electronic component according to Aspect (1), wherein

the electronic component is an asymmetric electronic component;

the liquid crystal polymer (A) has a content of 47.5 to 65 mass% based on the total amount of the composite resin composition;

the milled fiber (B) has a content of 15 to 30 mass%

based on the total amount of the composite resin composition;
and

the plate-like inorganic filler (C) has a content of 20 to 35 mass% based on the total amount of the composite resin composition;

(3) The composite resin composition for an electronic component according to Aspect (2), wherein the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica;

(4) The composite resin composition for an electronic component according to Aspect (1), wherein the electronic component is a low-profile narrow-pitch connector; and

the plate-like inorganic filler (C) has a content of 10 to 30 mass% based on the total amount of the composite resin composition;

(5) The composite resin composition for an electronic component according to Aspect (4), wherein the liquid crystal polymer (A) has a value [(melting point) - (crystallization temperature)] of 50°C to 60°C and a melt viscosity of 5 to 15 Pa·s measured in accordance with ISO11443 at a temperature higher than the melting point by 10°C to 20°C and a shear rate of 1000/sec;

(6) The composite resin composition for an electronic component according to Aspect (4) or (5), wherein the milled fiber (B) has an average fiber length of 50 to 100 μm ; and

the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica;

(7) An electronic component molded from the composite resin composition for an electronic component according to Aspect (1);

(8) The electronic component according to Aspect (7), the electronic component being an asymmetric electronic component not having symmetry with respect to any of the XY, YZ, and XZ axial planes of the molded article, wherein

the liquid crystal polymer (A) has a content of 47.5 to 65 mass% based on the total amount of the composite resin composition;

the milled fiber (B) has a content of 15 to 30 mass% based on the total amount of the composite resin composition; and

the plate-like inorganic filler (C) has a content of 20 to 35 mass% based on the total amount of the composite resin composition;

(9) The electronic component according to Aspect (8), wherein the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica;

(10) The electronic component according to Aspect (8) or (9), the electronic component being a memory module connector having a pitch distance of 0.8 mm or less, a product total length of 60.0 mm or more, a product height of 6.0 mm or less, and a pole number of 150 or more;

(11) The electronic component according to Aspect (8) or (9), the electronic component being a memory card socket having a rail structure and having a product height of 3.0 mm

or less;

(12) The electronic component according to Aspect (7), the electronic component being a low-profile narrow-pitch connector that is a board to board connector or a connector for flexible printed board, wherein

the plate-like inorganic filler (C) has a content of 10 to 30 mass% based on the total amount of the composite resin composition; and

the low-profile narrow-pitch connector has:

a pitch distance of 0.5 mm or less;

a product total length of 4.0 mm or more; and

a product height is 4.0 mm or less;

(13) The electronic component according to Aspect (12), wherein the liquid crystal polymer (A) has a value [(melting point) - (crystallization temperature)] of 50°C to 60°C and a melt viscosity of 5 to 15 Pa·s measured in accordance with ISO11443 at a temperature higher than the melting point by 10°C to 20°C and a shear rate of 1000/sec; and

(14) The electronic component according to Aspect (12) or (13), wherein

the glass fiber and milled fiber (B) has an average fiber length of 50 to 100 μm ; and

the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica.

Effects of the Invention

The present invention provides a composite resin composition for an electronic component having excellent

fluidity and an electronic component molded from the composite resin composition. A preferred embodiment of the present invention provides a composite resin composition for an electronic component having excellent fluidity and capable of producing an asymmetric electronic component having reduced warping deformation, and provides an asymmetric electronic component molded from the composite resin composition. A preferred embodiment of the present invention provides a composite resin composition having excellent fluidity and allowing production of a low-profile narrow-pitch connector, and provides a low-profile narrow-pitch connector molded from the composite resin composition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram illustrating a DDR-DIMM connector molded in an example. The reference sign "A" indicates the position of a gate.

FIG. 2 is a diagram indicating the points of measurement of warp in a DDR-DIMM connector performed in an example.

FIG. 3 includes diagrams illustrating a low-profile narrow-pitch connector (connector for flexible printed board) molded in an example. The unit of the numerical values in the diagrams is mm.

PREFERRED MODE FOR CARRYING OUT THE INVENTION

Embodiments of the present invention will now be specifically described.

[Composite resin composition]

The composite resin composition of the present invention contains a specific liquid crystal polymer, a glass fiber and/or milled fiber, and a plate-like inorganic filler in predetermined amounts. Each component of the composite resin composition according to the present invention will now be described.

(Liquid crystal polymer)

The liquid crystal polymer in the present invention includes a constitutional unit (I) derived from 4-hydroxybenzoic acid (also referred to as "HBA"), a constitutional unit (II) derived from 2-hydroxy-6-naphthoic acid (also referred to as "HNA"), a constitutional unit (III) derived from terephthalic acid (also referred to as "TA"), a constitutional unit (IV) derived from isophthalic acid (also referred to as "IA"), and constitutional unit (V) derived from 4,4'-dihydroxybiphenyl (also referred to as "BP"), as essential components.

The liquid crystal polymer in the present invention contains the above-mentioned constitutional units at specific proportions. That is, the content of the constitutional unit (I) is 35 to 75 mol% (preferably 40 to 65 mol%) based on the total amount of all of the constitutional units. The content of the constitutional unit (II) is 2 to 8 mol% (preferably 3 to 7 mol%) based on the total amount of all of the constitutional units. The content of the constitutional unit (III) is 4.5 to 30.5 mol% (preferably 13 to 26 mol%) based on

the total amount of all of the constitutional units. The content of the constitutional unit (IV) is 2 to 8 mol% (preferably 3 to 7 mol%) based on the total amount of all of the constitutional units. The content of the constitutional unit (V) is 12.5 to 32.5 mol% (preferably 15.5 to 29 mol%) based on the total amount of all of the constitutional units. The sum of the contents of the constitutional units (II) and (IV) is 4 to 10 mol% (preferably 5 to 10 mol%) based on the total amount of all of the constitutional units.

If the content of the constitutional unit (I) is less than 35 mol% or higher than 75 mol% based on the total amount of all of the constitutional units, the liquid crystal polymer has a significantly high melting point and solidifies in a reactor during the production of a molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, and a liquid crystal polymer having a desired molecular weight may not be prepared. Thus, such a content of the constitutional unit (I) is not preferred.

If the content of the constitutional unit (II) is less than 2 mol% based on the total amount of all of the constitutional units, cracking may occur in a molded article during the production of the molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector. Thus, such a content of the constitutional unit (II) is not preferred. If the content of the constitutional

unit (II) is higher than 8 mol% based on the total amount of all of the constitutional units, the liquid crystal polymer has low heat resistance. Thus, such a content of the constitutional unit (II) is not preferred.

If the content of the constitutional unit (III) is less than 4.5 mol% or higher than 30.5 mol% based on the total amount of all of the constitutional units, the liquid crystal polymer has a significantly high melting point and solidifies in a reactor during the production of a molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, and a liquid crystal polymer having a desired molecular weight may not be prepared. Thus, such a content of the constitutional unit (III) is not preferred.

If the content of the constitutional unit (IV) is less than 2 mol% based on the total amount of all of the constitutional units, cracking may occur in a molded article during the production of the molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector. Thus, such a content of the constitutional unit (IV) is not preferred. In addition, the liquid crystal polymer has a significantly high melting point and solidifies in a reactor during the production of a molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, and a liquid crystal polymer having a

desired molecular weight may not be prepared. Thus, such a content of the constitutional unit (IV) is not preferred.

If the content of the constitutional unit (IV) is higher than 8 mol% based on the total amount of all of the constitutional units, the liquid crystal polymer has low heat resistance. Thus, such a content of the constitutional unit (IV) is not preferred.

If the content of the constitutional unit (V) is less than 12.5 mol% or higher than 32.5 mol% based on the total amount of all of the constitutional units, the liquid crystal polymer has a significantly high melting point, the liquid crystal polymer solidifies in a reactor during the production of a molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, and a liquid crystal polymer having a desired molecular weight cannot be prepared. Thus, such a content of the constitutional unit (V) is not preferred.

If the sum of the contents of the constitutional units (II) and (IV) is less than 4 mol% based on the total amount of all of the constitutional units, the crystallization enthalpy of the liquid crystal polymer can be 2.5 J/g or more. In this case, cracking may occur in a molded article during the production of the molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector. Thus, such a total content of the constitutional units (II) and (IV)

is not preferred. The liquid crystal polymer preferably has a crystallization enthalpy of 2.3 J/g or less and more preferably 2.0 J/g or less. The crystallization enthalpy indicates the crystallized state of a liquid crystal polymer and is determined through differential calorimetry. Specifically, the crystallization enthalpy indicates the quantity of heat of an exothermic peak, which is determined as follows: A liquid crystal polymer is heated at a temperature rise rate of 20°C/min from room temperature to observe an endothermic peak temperature (T_{m1}); the liquid crystal polymer is retained at a temperature of $T_{m1}+40^{\circ}\text{C}$ for 2 minutes; the liquid crystal polymer is then cooled at a temperature fall rate of 20°C/min to observe an exothermic peak temperature; and the quantity of heat of the exothermic peak is determined from the peak of the exothermic peak temperature.

If the sum of the contents of the constitutional units (II) and (IV) is higher than 10 mol% based on the total amount of all of the constitutional units, the liquid crystal polymer has low heat resistance. Thus, such a total content of the constitutional units (II) and (IV) is not preferred.

The liquid crystal polymer in the present invention can further contain another known constitutional unit within a range that does not impair the purpose of the present invention.

The liquid crystal polymer in the present invention can be prepared by polymerizing the above-mentioned constitutional units by, for example, direct polymerization,

transesterification, melt polymerization, solution polymerization, slurry polymerization, or solid-phase polymerization.

In the polymerization of the constitutional units, an acylating agent for the constitutional units or a monomer having an activated terminal as an acid chloride derivative may be used together with the constitutional units. Examples of the acylating agent include acid anhydrides such as acetic anhydride.

The polymerization of the constitutional units can use various catalysts. Examples of the catalysts include dialkyl tin oxides, diaryl tin oxides, titanium dioxide, alkoxy titanium silicates, titanium alcoholates, alkali metal salts of carboxylic acid, alkaline earth metal salts, and Lewis acid salts (such as BF_3). The amount of the catalyst used is approximately 0.001 to 1 mass%, preferably approximately 0.003 to 0.2 mass%, based on the total amount of the constitutional units.

The polymerization may be performed under any conditions that allow the polymerization of the constitutional units to proceed. The conditions may be, for example, a reaction temperature of 200°C to 380°C and a final pressure of 0.1 to 760 Torr (i.e., 13 to 101080 Pa).

The polymerization may be performed through a process (one-stage system) of starting the reaction after feeding all of the raw material monomers, acylating agent, and catalyst in one reaction vessel, or may be a process (two-stage system) of

acylating raw material monomers corresponding to constitutional units (I), (II), and (V), i.e., acylating the hydroxyl groups of the constitutional unit derived from 4-hydroxybenzoic acid, the constitutional unit derived from 2-hydroxy-6-naphthoic acid, and 4,4'-dihydroxybiphenyl, with an acylating agent and then reacting them with raw material monomers corresponding to the constitutional units (III) and (IV), i.e., the carboxyl groups of terephthalic acid and isophthalic acid.

Although some liquid crystal polymers each containing constitutional units (I) to (V) may not form an anisotropic molten phase depending on the components and the sequence distribution in the liquid crystal polymers, the liquid crystal polymer in the present invention preferably forms an anisotropic molten phase, i.e., exhibits optical anisotropy during melting, from the point of having both thermal stability and easy workability.

The melt anisotropy can be confirmed through common polarized light inspection using an orthogonal polarizer. Specifically, melt anisotropy can be confirmed through observation of a molten sample on a hot stage (e.g., that manufactured by Linkam Scientific Instruments Ltd.) in a nitrogen atmosphere with a polarizing microscope (e.g., that manufactured by Olympus Corporation) at 150 magnification. A liquid crystal polymer exhibiting optical anisotropy during melting is optically anisotropic and transmits light when it is inserted between orthogonal polarizers. If a sample is

optically anisotropic, the sample transmits polarized light even in a state of rest of melting, for example.

In addition, a liquid crystal polymer having a melt viscosity of 1×10^5 Pa·s or less (more preferably 5 Pa·s or more and 1×10^2 Pa·s or less) measured in accordance with ISO11443 at a temperature higher than the melting point by 10°C to 20°C and a shear rate of 1000/sec is preferred due to the fact that the fluidity of the composite resin composition is secured and that it does not need excessive filling pressure in molding of an electronic component, in particular, in molding of a part having a complicated shape, such as a latch structure or a notch, of an asymmetric electronic component.

The liquid crystal polymer in the present invention preferably has a value [(melting point) - (crystallization temperature)], which is a value obtained by subtracting the crystallization temperature from the melting point, of 50°C to 60°C and a melt viscosity of 5 to 15 Pa·s measured in accordance with ISO11443 at a temperature higher than the melting point by 10°C to 20°C and a shear rate of 1000/sec. In such a liquid crystal polymer, since the fluidity of the composite resin composition can be secured in molding of an electronic component, in particular, in molding of a low-profile narrow-pitch connector, the filling pressure can be prevented from becoming excessively high.

In the composite resin composition of the present invention, the content of the liquid crystal polymer is 40 to 80 mass% based on the total amount of the composite resin

composition. If the content of the liquid crystal polymer is less than 40 mass% based on the total amount of the composite resin composition, the fluidity is deteriorated. Thus, such a content is not preferred. If the content of the liquid crystal polymer is higher than 80 mass% based on the total amount of the composite resin composition, the molded article molded from the composite resin composition, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, has a low bending elastic modulus and low cracking resistance. Thus, such a content is not preferred. The composite resin composition of the present invention preferably contains the liquid crystal polymer in an amount of 50 to 70 mass% based on the total amount of the composite resin composition.

When the composite resin composition of the present invention is used, in particular, for an asymmetric electronic component, the content of the liquid crystal polymer is preferably 47.5 to 65 mass% based on the total amount of the composite resin composition. When the content of the liquid crystal polymer is 47.5 mass% or more based on the total amount of the composite resin composition, the composite resin composition can readily have excellent fluidity, and the warping deformation of a molded article, such as an asymmetric electronic component, molded from the composite resin composition is restrained. Thus, such a content is preferred. When the content of the liquid crystal polymer is 65 mass% or

less based on the total amount of the composite resin composition, the bending elastic modulus and the cracking resistance of a molded article, such as an asymmetric electronic component, molded from the composite resin composition are hardly reduced. Thus, such a content is preferred. When the composite resin composition of the present invention is used, in particular, for an asymmetric electronic component, the content of the liquid crystal polymer in the composite resin composition is preferably 50 to 55 mass% based on the total amount of the composite resin composition.

(Milled fiber)

The composite resin composition of the present invention contains the liquid crystal polymer and a milled fiber, and thereby a molded article molded from the composite resin composition has excellent high-temperature rigidity.

In the composite resin composition of the present invention, the milled fiber preferably has an average fiber length of 50 to 150 μm , which is calculated from the fiber lengths of milled fibers. When the average fiber length is 50 μm or more, a molded article molded from the composite resin composition can have sufficient high-temperature rigidity. Thus, such an average fiber length is preferred. When the average fiber length is 150 μm or less, the composite resin composition can have excellent fluidity, and warping deformation of a molded article can be restrained. Thus, such an average fiber length is preferred.

When the composite resin composition of the present

invention is used, in particular, for a low-profile narrow-pitch connector, the milled fiber in the composite resin composition preferably has an average fiber length of 50 to 100 μm calculated from the fiber lengths of milled fibers. When the average fiber length is 50 μm or more, a molded article molded from the composite resin composition can have sufficient high-temperature rigidity. Thus, such an average fiber length is preferred. When the average fiber length is 100 μm or less, the composite resin composition has excellent fluidity, and difficulty in molding of the composite resin composition is restrained. Thus, such an average fiber length is preferred.

The fiber diameter of the milled fiber in the present invention is not particularly limited, however the fiber diameter used is typically approximately 5 to 15 μm .

The composite resin composition of the present invention contains a milled fiber in an amount of 10 to 30 mass% based on the total amount of the composite resin composition. If the content of the milled fiber is less than 10 mass% based on the total amount of the composite resin composition, the molded article molded from the composite resin composition, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, has a low load deflection temperature and insufficient high-temperature rigidity. Thus, such a content is not preferred. If the content of the milled fiber is higher than 30 mass% based on the total amount of the composite resin

composition, the fluidity of the composition is deteriorated. Thus, such a content is not preferred.

When the composite resin composition of the present invention is used, in particular, for an asymmetric electronic component, the content of the milled fiber is preferably 15 to 30 mass% based on the total amount of the composite resin composition. When the content of the milled fiber is 15 mass% or more based on the total amount of the composite resin composition, a molded article, such as an asymmetric electronic component, molded from the composite resin composition hardly causes a decrease in the load deflection temperature and has sufficient high-temperature rigidity. Thus, such a content is preferred. When the content of the milled fiber is 30 mass% or less based on the total amount of the composite resin composition, the composite resin composition has excellent fluidity, and warping deformation of a molded article can be restrained. Thus, such a content is preferred.

(Plate-like inorganic filler)

The composite resin composition of the present invention further contains a plate-like inorganic filler. The composite resin composition of the present invention can produce a molded article having less warping deformation by containing the plate-like inorganic filler.

The content of the plate-like inorganic filler is 10 to 35 mass% based on the total amount of the composite resin composition. If the content of the plate-like inorganic filler

is less than 10 mass% based on the total amount of the composite resin composition, a molded article molded from the composite resin composition is not sufficiently prevented from warping deformation. Thus, such a content is not preferred. If the content of the plate-like inorganic filler is higher than 35 mass% based on the total amount of the composite resin composition, the composite resin composition has deteriorated fluidity and has a risk of making molding difficult. Thus, such a content is not preferred.

When the composite resin composition is used, in particular, for an asymmetric electronic component, the content of the plate-like inorganic filler is preferably 20 to 35 mass% based on the total amount of the composite resin composition. When the content of the plate-like inorganic filler is 20 mass% or more based on the total amount of the composite resin composition, warping deformation of a molded article, such as an asymmetric electronic component, molded from the composite resin composition can be restrained. Thus, such a content is preferred. When the content of the plate-like inorganic filler is 35 mass% or less based on the total amount of the composite resin composition, the composite resin composition readily has excellent fluidity. Thus, such a content is preferred.

When the composite resin composition is used, in particular, for a low-profile narrow-pitch connector, the content of the plate-like inorganic filler is preferably 10 to 30 mass% based on the total amount of the composite resin

composition. When the content of the plate-like inorganic filler is 10 mass% or more based on the total amount of the composite resin composition, warping deformation of a molded article molded from the composite resin composition, such as a low-profile narrow-pitch connector, tends to be sufficiently restrained. Thus, such a content is preferred. When the content of the plate-like inorganic filler is 30 mass% or less based on the total amount of the composite resin composition, the composite resin composition has excellent fluidity, and difficulty in molding of the composite resin composition is restrained. Thus, such a content is preferred.

Examples of the plate-like inorganic filler in the present invention include talc, mica, glass flakes, and various types of metal foil. The plate-like inorganic filler is preferably one or more selected from the group consisting of talc and mica from the point of preventing warping deformation of the molded article molded from the composite resin composition and not deteriorating the fluidity of the composite resin composition. The plate-like inorganic filler may have any average particle diameter, but a smaller average particle diameter is desirable in light of the fluidity at a thin-walled portion. In contrast, in order to reduce the warping deformation of the molded article molded from the composite resin composition, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, the plate-like inorganic filler desirably maintains a certain

size. Specifically, the average particle diameter is preferably 1 to 100 μm and more preferably 5 to 50 μm .

(Talc)

As the talc that can be used in the present invention, based on the total solid amount of the talc, the total content of Fe_2O_3 , Al_2O_3 , and CaO is preferably 2.5 mass% or less, the total content of Fe_2O_3 and Al_2O_3 is preferably higher than 1.0 mass% and not higher than 2.0 mass%, and the content of CaO is preferably less than 0.5 mass%. That is, the talc that can be used in the present invention may contain at least one selected from Fe_2O_3 , Al_2O_3 , and CaO within the content ranges shown above, in addition to its main components SiO_2 and MgO .

When the total content of Fe_2O_3 , Al_2O_3 , and CaO in the talc is 2.5 mass% or less, the molding workability of the composite resin composition is hardly deteriorated, and the heat resistance of a molded article molded from the composite resin composition, for example, an electronic component, such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, is hardly deteriorated. The total content of Fe_2O_3 , Al_2O_3 , and CaO is preferably 1.0 mass% or more and 2.0 mass% or less.

In the above-described various types of talc, talc having a total content of Fe_2O_3 and Al_2O_3 of higher than 1.0 mass% is readily available. When the talc has a total content of Fe_2O_3 and Al_2O_3 of 2.0 mass% or less, the molding workability of the composite resin composition is hardly deteriorated, and the heat resistance of a molded article molded from the composite

resin composition, for example, an electronic component, such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, is hardly deteriorated. The total content of Fe_2O_3 and Al_2O_3 is preferably higher than 1.0 mass% and not higher than 1.7 mass%.

When the talc has a content of CaO of less than 0.5 mass%, the molding workability of the composite resin composition is hardly deteriorated, and the heat resistance of a molded article molded from the composite resin composition, for example, an electronic component, such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, is hardly deteriorated. The content of CaO is preferably 0.01 mass% or more and 0.4 mass% or less.

The talc in the present invention preferably has a mass-based or volume-based cumulative mean particle diameter (D_{50}) of 4.0 to 20.0 μm , more preferably 10 to 18 μm , measured by laser diffractometry, from the viewpoint of preventing warping deformation of the molded article and maintaining the fluidity of the composite resin composition.

(Mica)

Mica is a ground product of a silicate mineral containing aluminum, potassium, magnesium, sodium, iron, and so on. Examples of the mica that can be used in the present invention include muscovite, phlogopite, biotite, and micanite. Among them, muscovite is preferred because of its satisfactory hue and low cost.

Known methods of pulverizing a mineral for producing mica are classified into either a wet grinding process or a dry grinding process. In the wet grinding process, mica ore is coarsely ground with a dry mill, the resulting coarse mica is then mixed with water to form slurry, and the slurry is finely ground by wet grinding, followed by dehydration and drying. Although the dry grinding process is inexpensive, compared to the wet grinding process, and is a common process, the wet grinding process can easily grind a mineral into thin and fine particles. A thin and fine ground product can provide mica having preferred average particle diameter and thickness described below and therefore is preferably used in the present invention. Accordingly, in the present invention, mica prepared by a wet grinding process is preferably used.

In the wet grinding process, the grinding object is required to be dispersed in water. Thus, in order to enhance the dispersion efficiency of the grinding object, a flocculation/sedimentation agent and/or a flocculant is usually added to the grinding object. Examples of the flocculation/sedimentation agent and flocculant that can be used in the present invention include polyaluminum chloride, aluminum sulfate, ferrous sulfate, ferric sulfate, chlorinated copperas, polyferric sulfate, polyferric chloride, iron-silica inorganic polymer coagulant, ferric chloride-silica inorganic polymer coagulant, calcium hydroxide (Ca(OH)_2), sodium hydroxide (NaOH), and sodium carbonate (Na_2CO_3). These flocculation/sedimentation agents and flocculants have

alkaline or acidic pH levels. In the present invention, when the mica is prepared by wet grinding, preferably, no flocculation/sedimentation agent and/or flocculant is used. In the use of mica that has not been treated with any flocculation/sedimentation agent and/or flocculant, the polymer in a composite resin composition is scarcely decomposed, and generation of a large amount of gas and a decrease in the molecular weight of the polymer scarcely occur. Accordingly, a resulting molded article, for example, an electronic component such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector, can easily maintain higher quality.

The mica that can be used in the present invention preferably has an average particle diameter of 10 to 100 μm , more preferably 20 to 80 μm , measured by microtrac laser diffractometry. When the mica has an average particle diameter of 10 μm or more, a sufficient effect of improving the rigidity of a molded article is readily obtained. Thus, such a size is preferred. When the mica has an average particle diameter of 100 μm or less, a sufficient improvement in the rigidity of a molded article and a sufficient welding strength are readily obtained. Thus, such a size is preferred. In addition, an average particle diameter of mica of 100 μm or less can easily secure fluidity sufficient for molding, for example, an electronic component of the present invention, such as an asymmetric electronic component, a low-profile narrow-pitch connector, or a coaxial connector.

The mica that can be used in the present invention preferably has a thickness of 0.01 to 1 μm , more preferably 0.03 to 0.3 μm , actually measured with an electron microscope. The mica having a thickness of 0.01 μm or more is scarcely broken in melt processing of the composite resin composition. Thus, such a thickness has a possibility of easily enhancing the rigidity of a molded article and is therefore preferred. A thickness of 1 μm or less of mica sufficiently improves the rigidity of a molded article and is therefore preferred.

The mica that can be used in the present invention may be surface-treated with, for example, a silane coupling agent and/or may be granulated into granulates with a binder.

(Other components)

The composite resin composition of the present invention may further contain at least one selected from nucleating agents, carbon black, pigments such as inorganic fired pigments, antioxidants, stabilizers, plasticizers, lubricants, mold release agents, flame retardants, and known inorganic fillers, in addition to the above-mentioned components.

The composite resin composition of the present invention can be prepared by any process that can uniformly mix the components of the composite resin composition and can be prepared by a process appropriately selected from conventionally known processes for producing resin compositions. The composite resin composition is prepared, for example, by melting and kneading the components and extruding the mixture with a melt kneader, such as a single- or twin-

screw extruder, and processing the resulting composite resin composition into a desired form, such as powder, flake, or pellet.

The composite resin composition of the present invention has excellent fluidity. Accordingly, the minimum filling pressure during molding is prevented from being excessively increased, which is preferable for forming, for example, a part having a complicated shape, such as an asymmetric electronic component having a latch structure, a notch, or the like, a part having a small and complicated shape, such as a low-profile narrow-pitch connector and a coaxial connector. The minimum filling pressure is identified as a minimum injection filling pressure for molding the composite resin composition at 365°C into a satisfactory molded article.

[Electronic component]

The electronic component of the present invention can be prepared by molding the composite resin composition of the present invention. The electronic component is not particularly limited, and examples thereof include asymmetric electronic components, low-profile narrow-pitch connectors, and coaxial connectors.

(Asymmetric electronic component)

The asymmetric electronic component of the present invention can be prepared by molding the composite resin composition of the present invention. The term "asymmetric electronic component" of the present invention refers to that not having symmetry with respect to any of the XY, YZ, and XZ

axial planes of the molded article.

Ordinary connectors (electronic components) widely distributed in the market have symmetry with respect to any of the XY, YZ, and XZ axial planes, and the dimensional accuracy and warp of a product can be controlled by adjusting the gate position and design so as to maintain the symmetry in the molding. Contrary to this, the asymmetric electronic component of the present invention has a complicated shape and is difficult to be prevented from warping deformation through the molding procedure. The asymmetric electronic component of the present invention can be prevented from warping deformation by using a specific composite resin composition.

Typical examples of such asymmetric electronic components are some kinds of connectors and sockets.

Examples of the connector include memory module connectors such as DIMM connectors, DDR-DIMM connectors, DDR2-DIMM connectors, DDR-SO-DIMM connectors, DDR2-SO-DIMM connectors, DDR-Micro-DIMM connectors, and DDR2-Micro-DIMM connectors. Among them, preferred are DDR-DIMM connectors and DDR2-DIMM connectors, in particular. Most preferred are memory module connectors having thin walls and complicated shapes for notebook personal computers, each having a pitch distance of 0.8 mm or less, product total length of 60.0 mm or more, a product height of 6.0 mm or less, and a pole number of 150 or more. Such a memory module connector is subjected to an IR reflow process for surface mounting at a peak temperature of 230°C to 280°C and is required to have a warp of 0.1 mm or less

before the IR reflow process and a difference in the warp between before and after the reflow of 0.05 mm or less. The present invention can satisfy such requirements.

Examples of the socket includes memory card sockets such as card buses, CF cards, memory sticks, PC cards, SD cards, secure data access modules (SDMos), smart cards, smart media cards, micro SD cards, mini SD cards, xD picture cards, and TransFlash. In particular, memory card sockets having a rail structure and having a product height of 3.0 mm or less are preferred.

(Low-profile narrow-pitch connector)

The low-profile narrow-pitch connector of the present invention can be prepared by molding the composite resin composition of the present invention. The low-profile narrow-pitch connector of the present invention may have any shape and may have a pitch distance of 0.5 mm or less, a product total length of 4.0 mm or more, and a product height of 4.0 mm or less. The low-profile narrow-pitch connector of the present invention may be any type and may be a board to board connector (also known as "B to B connector") or a connector for flexible printed board for connecting a flexible printed circuit (FPC) and a flexible flat cable (FFC) (also known as "connector for FPC").

(Coaxial connector)

The coaxial connector of the present invention can be produced by molding the composite resin composition of the present invention. In order to produce a coaxial connector by

molding a resin composition, the resin composition is required to have excellent fluidity. Since the composite resin composition of the present invention has excellent fluidity, a coaxial connector can be smoothly produced using the composite resin composition of the present invention. The coaxial connector is not particularly limited and is typically one having a thickness of 100 μm or less.

Although the electronic component of the present invention, such as the asymmetric electronic component, the low-profile narrow-pitch connector, and the coaxial connector of the present invention, may be molded by any process, in order to prevent, for example, deformation of the resulting electronic component, in particular, in order to prevent warping deformation of the asymmetric electronic component or prevent, for example, deformation of the resulting low-profile narrow-pitch connector or coaxial connector, molding conditions not causing residual internal stress are preferred. The cylinder temperature of a molding machine is preferably higher than the melting point of a liquid crystal polymer for reducing the filling pressure and reducing the residual internal stress of the resulting electronic component, such as an asymmetric electronic component, a low-profile narrow-pitch connector, and a coaxial connector.

The mold temperature is preferably 70°C to 100°C. A mold temperature being not too low, in particular, a mold temperature of 70°C or more hardly causes insufficient flowing of the composite resin composition packed in a mold and is

therefore preferred. A mold temperature being not too high, in particular, a mold temperature of 100°C or less scarcely causes problems, such as flash, and is therefore preferred. Molding is preferably performed at an injection speed of 150 mm/sec or more. When the injection speed is not too low, in particular, when the injection speed is 150 mm/sec or more, a risk of merely forming unfilled molded articles is low; completely filled molded articles scarcely have a high filling pressure and a high residual internal stress; and a risk of merely forming electronic components having a problem in shape, such as an asymmetric electronic component having large warping deformation and a connector having poor flatness, is low.

In particular, the asymmetric electronic component of the present invention has reduced warping deformation. The degree of warp of an asymmetric electronic component is determined as follows. That is, an asymmetric electronic component is placed on a horizontal table. The height of the asymmetric electronic component is measured with an image measuring apparatus. The difference between the maximum height and the minimum height from a least squares plane is defined as the warp of the asymmetric electronic component. The asymmetric electronic component of the present invention is prevented from changing in warp before and after IR reflow.

The electronic component of the present invention, such as the asymmetric electronic component, the low-profile narrow-pitch connector, or the coaxial connector of the present invention, has excellent high-temperature rigidity.

The high-temperature rigidity can be evaluated by measuring the load deflection temperature in accordance with ISO75-1, 2.

EXAMPLES

The present invention will now be specifically described by examples, but is not limited to them.

(Process of producing liquid crystal polymer 1)

A polymerization vessel equipped with a stirrer, a reflux column, a monomer input port, a nitrogen inlet port, and a pressure reducing/outflow line was fed with the raw material monomers, a metal catalyst, and acylating agent shown below, and nitrogen purge was started.

(I) 4-hydroxybenzoic acid: 1041 g (48 mol%) (HBA)

(II) 6-hydroxy-2-naphthoic acid: 89 g (3 mol%) (HNA)

(III) terephthalic acid: 565 g (21.7 mol%) (TA)

(IV) isophthalic acid: 78 g (3 mol%) (IA)

(V) 4,4'-dihydroxybiphenyl: 711 g (24.3 mol%) (BP)

Potassium acetate catalyst: 110 mg

Acetic anhydride: 1645 g

After feeding of the raw materials into the polymerization vessel, the temperature of the reaction system was raised to 140°C, and reaction was performed at 140°C for 1 hour. The temperature was then further raised to 360°C over 5.5 hours. Subsequently, the pressure was reduced to 10 Torr (i.e., 1330 Pa) over 20 minutes. Thus, melt polymerization was performed while acetic acid, excessive acetic anhydride, and other low boiling components were being distilled. After the

stirring torque reached a predetermined value, nitrogen was introduced for increasing the pressure from the reduced state, through a normal pressure, to a pressurized state to discharge the polymer from a lower part of the polymerization vessel. The resulting strand was pelletized into a pellet. The resulting pellet had a melting point of 358°C, a crystallization temperature of 303°C, a crystallization enthalpy of 1.6 J/g, and a melt viscosity of 9 Pa.s.

In this example, the melting point, crystallization temperature, crystallization enthalpy, and melt viscosity of the pellet were measured under the following conditions, respectively.

[Measurement of melting point]

The melting point was measured with DSC manufactured by TA Instruments Japan Inc. as follows: A liquid crystal polymer was heated at a temperature rise rate of 20°C/min from room temperature to observe an endothermic peak temperature (T_{m1}), was retained at a temperature of $T_{m1}+40^{\circ}\text{C}$ for 2 minutes, was then cooled at a temperature fall rate of 20°C/min to room temperature, and was heated at a temperature rise rate of 20°C/min again to observe an endothermic peak temperature; and the temperature of the endothermic peak was measured as the melting point.

[Measurement of crystallization temperature]

The crystallization temperature was measured with DSC manufactured by TA Instruments Japan Inc. as follows: A liquid crystal polymer was heated at a temperature rise rate of

20°C/min from room temperature to observe an endothermic peak temperature (T_{m1}), was retained at a temperature of $T_{m1}+40^{\circ}\text{C}$ for 2 minutes, and was then cooled at a temperature fall rate of 20°C/min to observe an exothermic peak temperature; and the exothermic peak temperature was measured as the crystallization temperature.

[Measurement of crystallization enthalpy]

The crystallization enthalpy was measured with DSC manufactured by TA Instruments Japan Inc. as follows: A composition composed of all of aromatic polyesters and polyester resin was heated at a temperature rise rate of 20°C/min from room temperature to observe an endothermic peak temperature (T_{m1}), was retained at a temperature of $T_{m1}+40^{\circ}\text{C}$ for 2 minutes, and was then cooled at a temperature fall rate of 20°C/min to observe an exothermic peak temperature; and the quantity of heat of the exothermic peak was determined from the peak of the exothermic peak temperature as the crystallization enthalpy.

[Measurement of melt viscosity]

The melt viscosity of a liquid crystal polymer was measured in accordance with ISO11443 at a temperature higher than the melting point of the liquid crystal polymer by 10°C to 20°C and a shear rate of 1000/sec with Capillograph 1B (L = 20 mm, d = 1 mm) manufactured by Toyo Seiki Seisaku-sho, Ltd.

(Process of producing liquid crystal polymer 2)

A polymerization vessel equipped with a stirrer, a reflux column, a monomer input port, a nitrogen inlet port, and a

pressure reducing/outflow line was fed with the raw material monomers, metal catalyst, and acylating agent shown below, and nitrogen purge was started.

(I) 4-hydroxybenzoic acid: 188.4 g (60 mol%) (HBA)

(II) 6-hydroxy-2-naphthoic acid: 21.4 g (5 mol%) (HNA)

(III) terephthalic acid: 66.8 g (17.7 mol%) (TA)

(IV) 4,4'-dihydroxybiphenyl: 52.2 g (12.3 mol%) (BP)

(V) 4-(acetoxymino)phenol: 17.2 g (5 mol%) (APAP)

Potassium acetate catalyst: 15 mg

Acetic anhydride: 226.2 g

After feeding of the raw materials into the polymerization vessel, the temperature of the reaction system was raised to 140°C, and reaction was performed at 140°C for 1 hour. The temperature was then further raised to 340°C over 4.5 hours. Subsequently, the pressure was reduced to 10 Torr (i.e., 667 Pa) over 15 minutes. Thus, melt polymerization was performed while acetic acid, excessive acetic anhydride, and other low boiling components were being distilled. After the stirring torque reached a predetermined value, nitrogen was introduced for increasing the pressure from the reduced state, through a normal pressure, to a pressurized state to discharge the polymer from a lower part of the polymerization vessel. The resulting strand was pelletized into a pellet. The resulting pellet had a melting point of 334°C, a crystallization temperature of 290°C, a crystallization enthalpy of 2.7 J/g, and a melt viscosity of 18 Pa.s. (Components other than liquid crystal polymer)

Each liquid crystal polymer prepared above and the following components were mixed with a twin-screw extruder to prepare each composite resin composition. The blended amounts of the components are shown in Tables 1 to 3. Glass fiber and/or milled fiber (B)

Glass fiber: ECS03T-786H, a chopped strand having a fiber diameter of 10 μm and a length of 3 mm, manufactured by Nippon Electric Glass Co., Ltd.

Milled fiber: PF70E001, fiber diameter: 10 μm , average fiber length: 70 μm , manufactured by Nitto Boseki Co., Ltd.
Plate-like inorganic filler (C)

Talc: Crown Talc PP, average particle diameter: 10 μm , manufactured by Matsumura Sangyo Co., Ltd.

Mica: AB-25S, average particle diameter: 25 μm , manufactured by Yamaguchi Mica Co., Ltd.

The extrusion conditions for preparing the composite resin composition were as follows.

[Extrusion conditions]

Examples 1 to 11, Comparative Examples 4, 5, 10, 11 and
Reference Examples 1 to 4

The temperature of the cylinder placed at the main feed port was set to 250°C, and those of other cylinders were set to 370°C. All of liquid crystal polymers were supplied through the main feed port. The filler was supplied through the side feed port.

Comparative Examples 1 to 3 and 6 to 9

The temperature of the cylinder placed at the main feed

port was set to 250°C, and those of other cylinders were set to 350°C. All of liquid crystal polymers were supplied through the main feed port. The filler was supplied through the side feed port.

The average glass fiber lengths of the glass fiber and the milled fiber in the composite resin composition were measured by the following process.

[Measurement of average glass fiber length]

A pellet (5 g) of the composite resin composition was heated at 600°C for 2 hours for incineration. The incineration residue was thoroughly dispersed in an aqueous solution of 5 mass% of polyethylene glycol. The dispersion was transferred to a petri dish with a syringe and was subjected to observation of the glass fiber or the milled fiber with a microscope. At the same time, the weight-average fiber length of the glass fiber or the milled fiber was measured with an image measuring apparatus (LUZEXFS, manufactured by Nireco Corporation).

Production and evaluation of asymmetric electronic component

The physical properties of a DDR-DIMM connector molded from the composite resin composition were measured by the following processes. Table 1 shows the results of each evaluation.

(Warp of DDR connector)

A DDR-DIMM connector having a total size of 70.0 mm × 26.0 mm × 4.0 mm, a pitch distance of 0.6 mm, and a number of pin holes of 100 × 2, as shown in FIG. 1, was molded by

injection molding (gate: tunnel gate, gate size: ϕ 0.75 mm) of a composite resin composition under the following molding conditions.

[Molding conditions]

Molding machine: Sumitomo Heavy Industries, Ltd., SE30DUZ

Cylinder temperature (referring to the temperature from the nozzle side):

360°C-365°C-340°C-330°C (in Examples 1 to 3, Comparative Examples 4 and 5, and Reference Examples 1 and 2)

350°C-350°C-340°C-330°C (Comparative Examples 1 to 3)

Mold temperature: 80°C

Injection speed: 300 mm/sec

Support pressure: 50 MPa

Pressure keeping time: 2 seconds

Cooling time: 10 seconds

Screw rotation speed: 120 rpm

Screw back pressure: 1.2 MPa

The resulting connector was placed on a horizontal table. The height of the connector was measured with an image measuring apparatus, Quick Vision 404PROCNC, manufactured by Mitutoyo Corporation). The heights were measured at a plurality of positions indicated with black circles in FIG. 2. The difference between the maximum height and the minimum height from a least squares plane was defined as the warp of the DDR connector. The warp was measured before and after the IR reflow under the following conditions.

[IR reflow conditions]

Measuring apparatus: large tabletop reflow soldering equipment, RF-300 (using a far infrared heater), manufactured by Japan Pulse Laboratories, Inc.

Sample feed rate: 140 mm/sec

Time for passing through reflow furnace: 5 minutes

Temperature of preheat zone: 150°C

Temperature of reflow zone: 190°C

Peak temperature: 251°C

(Deformation amount of DDR connector)

The difference in warp between before and after the reflow measured by the above-described process was defined as the deformation amount of the DDR connector.

(Minimum filling pressure for DDR connector)

The minimum injection filling pressure for providing a satisfactory molded article, a DDR-DIMM connector shown in FIG. 1, by injection molding was measured as the minimum filling pressure.

(Load deflection temperature)

A molded article was produced by injection molding of a composite resin composition under the following molding conditions. The load deflection temperature was measured in accordance with ISO75-1,2.

[Molding conditions]

Molding machine: Sumitomo Heavy Industries, Ltd., SE100DU

Cylinder temperature (referring to the temperature from the nozzle side):

360°C-370°C-370°C-360°C-340°C-330°C (Examples 1 to 3,

Comparative Examples 4 and 5, and Reference Examples 1 and 2)

350°C-350°C-350°C-350°C-340°C-330°C (Comparative Examples 1 to 3)

Mold temperature: 80°C

Injection speed: 2 m/min

Support pressure: 50 MPa

Pressure keeping time: 2 seconds

Cooling time: 10 seconds

Screw rotation speed: 120 rpm

Screw back pressure: 1.2 MPa

[Table 1]

		Example			Comparative Example					Reference Example	
		1	2	3	1	2	3	4	5	1	2
Liquid crystal polymer 1	mass%	50	50	50				55	45	60	55
Liquid crystal polymer 2	mass%				55	65	50				
Talc	mass%	20	30	35	30	15	30	15	25	10	15
Glass fiber	mass%				15	20		30	30		
Milled fiber	mass%	30	20	15			20			30	30
Average glass fiber length	μm	70	70	70	350	500	70	346	316	70	70
Warp of DDR connector (before reflow)	mm	0.081	0.059	0.072	0.070	0.176	0.067	0.101	0.120	0.093	0.089
Warp of DDR connector (after reflow)	mm	0.110	0.092	0.104	0.087	0.232	0.070	0.179	0.177	0.183	0.144
Deformation amount of DDR connector	mm	0.029	0.034	0.032	0.017	0.056	0.003	0.078	0.057	0.090	0.055
Minimum filling pressure for DDR connector	MPa	137	131	124	160	160	155	126	172	110	121
Load deflection temperature	°C	242	236	235	260	265	234	265	258	242	241

As shown in Table 1, the composite resin compositions of the present invention had excellent fluidity, and the asymmetric electronic components molded from the composite

resin compositions were prevented from warping deformation and had excellent high-temperature rigidity.

Production and evaluation of low-profile narrow-pitch connector

The connector minimum filling pressure and the load deflection temperature during molding of a low-profile narrow-pitch connector were measured in accordance with the following process. Tables 2 and 3 show the results. The term "not fillable" in Table indicates that the composite resin composition could not be packed in the molding machine.

(Minimum filling pressure for connector)

An FPC connector having a total size of 17.6 mm × 4.00 mm × 1.16 mm, a pitch distance of 0.5 mm, a number of pin holes of 30 × 2, and a minimum thickness of 0.12 mm, as shown in FIG. 3, was molded by injection molding (gate: tunnel gate, gate size: ϕ 0.4 mm) of a composite resin composition under the following molding conditions. The minimum injection filling pressure for providing a satisfactory molded article was measured as the minimum filling pressure.

[Molding conditions]

Molding machine: Sumitomo Heavy Industries, Ltd., SE30DUZ

Cylinder temperature (referring to the temperature from the nozzle side):

365°C-365°C-355°C-345°C (Examples 4 to 11, Comparative Examples 10 and 11, and Reference Examples 3 and 4)

350°C-350°C-340°C-330°C (Comparative Examples 6 to 9)

Mold temperature: 80°C

Injection speed: 12 m/min

Support pressure: 50 MPa

Pressure keeping time: 2 seconds

Cooling time: 5 seconds

Screw rotation speed: 120 to 100 rpm

Screw back pressure: 1.5 to 1.0 MPa

(Load deflection temperature)

Molded articles were prepared by injection molding of each composite resin composition under the following molding conditions. The load deflection temperatures were measured in accordance with ISO75-1,2.

[Molding conditions]

Molding machine: Sumitomo Heavy Industries, Ltd., SE100DU

Cylinder temperature (referring to the temperature from the nozzle side):

360°C-370°C-370°C-360°C-340°C-330°C (Examples 4 to 11, Comparative Examples 10 and 11, and Reference Examples 3 and 4)

350°C-350°C-350°C-350°C-340°C-330°C (Comparative Examples 6 to 9)

Mold temperature: 80°C

Injection speed: 2 m/min

Support pressure: 50 MPa

Pressure keeping time: 2 seconds

Cooling time: 10 seconds

Screw rotation speed: 120 rpm

Screw back pressure: 1.2 MPa

[Table 2]

		Example							
		4	5	6	7	8	9	10	11
Liquid crystal polymer 1	mass%	70	70	60	60	55	55	50	50
Talc	mass%	20		30	10	30	15	20	30
Mica	mass%		20						
Glass fiber	mass%								
Milled fiber	mass%	10	10	10	30	15	30	30	20
Average glass fiber length	μm	70	70	70	70	70	70	70	70
Minimum filling pressure for connector	MPa	82	83	103	97	110	108	129	123
Load deflection temperature	$^{\circ}\text{C}$	223	225	227	242	232	241	242	236

[Table 3]

		Comparative Example						Reference Example	
		6	7	8	9	10	11	3	4
Liquid crystal polymer 1	mass%					55	45	55	50
Liquid crystal polymer 2	mass%	70	65	55	50				
Talc	mass%	20	15	30	30	15	25	30	35
Mica	mass%								
Glass fiber	mass%		20	15		30	30	15	
Milled fiber	mass%	10			20				15
Average glass fiber length	μm	70	500	350	70	346	316	354	70
Minimum filling pressure for connector	MPa	138	not fillable	not fillable	not fillable	not fillable	not fillable	140	147
Load deflection temperature	$^{\circ}\text{C}$	221	265	260	234	265	258	257	235

As shown in Tables 2 and 3, the composite resin compositions of the present invention had excellent fluidity, and the low-profile narrow-pitch connector molded from the

composite resin composition of the present invention had reduced minimum filling pressure.

CLAIMS

1. A composite resin composition for an electronic component, the composition comprising a liquid crystal polymer (A), a milled fiber (B), and a plate-like inorganic filler (C); wherein

the liquid crystal polymer (A) includes a constitutional unit (I) derived from 4-hydroxybenzoic acid, a constitutional unit (II) derived from 2-hydroxy-6-naphthoic acid, a constitutional unit (III) derived from terephthalic acid, a constitutional unit (IV) derived from isophthalic acid, and constitutional unit (V) derived from 4,4'-dihydroxybiphenyl, as essential components;

the constitutional unit (I) has a content of 35 to 75 mol% based on the total amount of all of the constitutional units;

the constitutional unit (II) has a content of 2 to 8 mol% based on the total amount of all of the constitutional units;

the constitutional unit (III) has a content of 4.5 to 30.5 mol% based on the total amount of all of the constitutional units;

the constitutional unit (IV) has a content of 2 to 8 mol% based on the total amount of all of the constitutional units;

the constitutional unit (V) has a content of 12.5 to 32.5 mol% based on the total amount of all of the constitutional units;

the sum of the contents of the constitutional units (II)

and (IV) is 4 to 10 mol% based on the total amount of all of the constitutional units;

the liquid crystal polymer (A) has a content of 40 to 80 mass% based on the total amount of the composite resin composition;

the milled fiber (B) has a content of 10 to 30 mass% based on the total amount of the composite resin composition; and

the plate-like inorganic filler (C) has a content of 10 to 35 mass% based on the total amount of the composite resin composition.

2. The composite resin composition for an electronic component according to Claim 1, wherein

the electronic component is an asymmetric electronic component;

the liquid crystal polymer (A) has a content of 47.5 to 65 mass% based on the total amount of the composite resin composition;

the milled fiber (B) has a content of 15 to 30 mass% based on the total amount of the composite resin composition; and

the plate-like inorganic filler (C) has a content of 20 to 35 mass% based on the total amount of the composite resin composition.

3. The composite resin composition for an electronic

component according to Claim 2, wherein the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica.

4. The composite resin composition for an electronic component according to Claim 1, wherein

the electronic component is a low-profile narrow-pitch connector; and

the plate-like inorganic filler (C) has a content of 10 to 30 mass% based on the total amount of the composite resin composition.

5. The composite resin composition for an electronic component according to Claim 4, wherein the liquid crystal polymer (A) has a value [(melting point) - (crystallization temperature)] of 50°C to 60°C and a melt viscosity of 5 to 15 Pa·s measured in accordance with ISO11443 at a temperature higher than the melting point by 10°C to 20°C and a shear rate of 1000/sec.

6. The composite resin composition for an electronic component according to Claim 4 or 5, wherein

the milled fiber (B) has an average fiber length of 50 to 100 μm ; and

the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica.

7. An electronic component molded from the composite resin composition for an electronic component according to Claim 1.

8. The electronic component according to Claim 7, the electronic component being an asymmetric electronic component not having symmetry with respect to any of the XY, YZ, and XZ axial planes of the molded article, wherein

the liquid crystal polymer (A) has a content of 47.5 to 65 mass% based on the total amount of the composite resin composition;

the milled fiber (B) has a content of 15 to 30 mass% based on the total amount of the composite resin composition; and

the plate-like inorganic filler (C) has a content of 20 to 35 mass% based on the total amount of the composite resin composition.

9. The electronic component according to Claim 8, wherein the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica.

10. The electronic component according to Claim 8 or 9, the electronic component being a memory module connector having a pitch distance of 0.8 mm or less, product total length of 60.0 mm or more, a product height of 6.0 mm or less, and a pole number of 150 or more.

11. The electronic component according to Claim 8 or 9, the electronic component being a memory card socket having a rail structure and having a product height of 3.0 mm or less.

12. The electronic component according to Claim 7, the electronic component being a low-profile narrow-pitch connector that is a board to board connector or a connector for flexible printed board, wherein

the plate-like inorganic filler (C) has a content of 10 to 30 mass% based on the total amount of the composite resin composition; and

the low-profile narrow-pitch connector has:

a pitch distance of 0.5 mm or less;

a product total length of 4.0 mm or more; and

a product height is 4.0 mm or less.

13. The electronic component according to Claim 12, wherein the liquid crystal polymer (A) has a value [(melting point) - (crystallization temperature)] of 50°C to 60°C and a melt viscosity of 5 to 15 Pa·s measured in accordance with ISO11443 at a temperature higher than the melting point by 10°C to 20°C and a shear rate of 1000/sec.

14. The electronic component according to Claim 12 or 13, wherein

the milled fiber (B) has an average fiber length of 50 to 100 μm ; and

the plate-like inorganic filler (C) is one or more selected from the group consisting of talc and mica.