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SURFACE MOUNT TYPE ELECTRONIC COMPONENTS

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

5 The present invention relates to surface mount type electronic components which causes less flux migration when being mounted on the surface of a device such as circuit board.

ART RELATED

10 Thermoplastic liquid-crystalline polymer (which is abbreviated as "LCP" hereinafter) has good properties including heat resistance, mechanical properties such as rigidity, chemical resistance and dimensional accuracy. Due to those properties, LCPs are used not only for manufacturing molded articles but also for a variety of
15 products including fibers and films.

In the information and telecommunication fields, very thin parts are sometimes required. Particularly, personal computers and mobile phones employ highly integrated devices and the art wishes to use downsized,
20 thinner and smaller parts for them. Because of those excellent properties of the LCPs, consumption of LCPs has been increasing in these days.

In manufacturing electronic devices, surface mount type electronic components such as switch, relay,
25 connector, condenser, coil, trans, semiconductor, resistor



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and the like, are generally mounted on the surface of a substrate such as circuit board by means of soldering. In the soldering process, cream solder or solder paste is printed on the board, the electronic components are put on the printed board and the printed board is heated with a solder reflowing device to effect soldering.

LCPs are proposed to be used for manufacturing surface mount type electronic components (Japanese Patent Application Laid Open No. H08-143654). However, electronic components made of LCPs have some problems such as warpage of the components upon soldering due to the higher reflow temperatures. The warped components easily invite flux migration upon soldering, i.e. flux in the cream solder migrates into the small gap between the polymer component and the metal component generated by the warpage due to the capillary phenomenon.

For mounting electronic components such as connectors on electronic devices, environmentally conscious lead free solders are preferably used in these days. For example, the Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) adopted by the European Union on July 1, 2006 strongly restrict the use of hazardous substances including lead. In order to meet the directive, solder alloys used for mounting electronic components on the

surface of a substrate such as a circuit board have been switched to lead free solder alloys.

The reflow temperatures of the lead free solder alloys, such as Sn-Ag-Cu, Sn-Ag and Sn-Cu alloys, are about 200-250°C and are higher than the conventional Sn-Pb solder alloy whose reflow temperature is about 180°C. Due to the higher reflow temperatures, soldering with a lead free solder alloy usually conducted at higher reflow temperatures.

Because of the higher reflow temperatures, the problem of flux migration, i.e. the problem of electronic components made of LCP became more significant when a cream solder comprising a lead free solder alloy is used.

In order to avoid the development of warpage which cause flux migration, admixing fibrous fillers such as glass fiber having number average length is less than 100µm and aluminum borate whisker, and lamellar filler such as talc to the LCP composition has been proposed (Japanese Patent Application Laid Open 2002-294038).

SUMMARY OF THE INVENTION

An object of the present invention is to provide a surface mount type electronic component which causes less flux migration upon soldering the same on the surface of a substrate, such as a circuit board. Another object of the present invention is to provide a LCP composition suitable

for manufacturing surface mount type electronic component which cause less flux migration problem upon soldering the same on the surface of a substrate.

Accordingly, the present invention provides a surface mount type electronic device, which is obtained by molding a liquid crystalline polymer composition comprising:

100 parts by weight of a wholly aromatic liquid crystalline polymer having a crystalline melting temperature of 310-410°C, and

5-100 parts by weight of a glass fiber having a number average diameter of 4-8 μ m and a number average length of 100-200 μ m;

wherein the LCP composition has a deflection temperature under load (DTUL) of 280-360°C.

In another aspect of the present invention, a LCP composition comprising:

100 parts by weight of a wholly aromatic liquid crystalline polymer having a crystalline melting temperature of 310-410°C, and

5-100 parts by weight of a glass fiber having a number average diameter of 4-8 μ m and a number average length of 100-200 μ m;

wherein the LCP composition has a deflection temperature under load (DTUL) of 280-360°C is provided.

In a further aspect of the present invention, a method for mounting the electronic component of the invention on the surface of a circuit board, which comprises the step of soldering the component on the surface of the board using a cream solder which comprises a solder alloy and a flux.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1-1 Perspective view of a test piece with a metal terminal inserted therein which was used for the flux migration test. A represents resin part of the test piece and B represents the metal terminal inserted in the resin part.

Figure 1-2 The precise size of the test piece of figure 1-1 is shown. The numerical values in the figure represent the size in mm.

Figure 2-1 Perspective view of a connector test piece which was used for the warpage development test.

Figure 2-2 The precise size of the connector test piece of figure 2-1 is shown. The numerical values in the figure represent the size in mm.

BEST MODE FOR CARRYING OUT THE INVENTION

The LCP used in the present invention is liquid-crystalline polyester or liquid-crystalline polyester amide which exhibits anisotropic melt phase and is called as thermotropic LCP by those skilled in the art.

The anisotropic melt phase of the LCP can be confirmed by means of conventional polarized light system using orthogonal light polarizer. In more detail, the sample on the Leitz's hot stage under nitrogen atmosphere
5 may be observed with Leitz's polarization microscope.

The LCP used in the present invention is a wholly aromatic liquid-crystalline polymer whose molecular chain consists of aromatic groups and do not contain aliphatic repeating unit such as ethylene dioxy unit.

10 The LCP used in the invention has a crystalline melting temperature (T_m) of 310-410°C, preferably 310-370°C and especially, 310-340°C.

In the specification and claims, the crystalline melting temperature is the value determined by the
15 following method:

<Method for determining the crystalline melting temperature>

The differential scanning calorimeter (DSC) Exstar 6000 (Seiko Instruments Inc., Chiba, Japan) or the
20 same type of DSC device is used. The LCP sample to be examined is heated from room temperature at a rate of 20°C/minute and the endothermic peak (T_{m1}) is recorded. Thereafter, the sample is kept at a temperature 20-50°C higher than T_{m1} for 10 minutes. The sample is then cooled
25 to room temperature at the rate of 20°C/minute and is

heated again at the rate of 20°C/minute. Endothermic peak found in the final step is recorded as crystalline melting temperature (T_m) of the sample LCP.

5 Examples of repeating units in the LCP are aromatic repeating units such as aromatic oxycarbonyl, aromatic di-carbonyl, aromatic dioxy, aromatic aminooxy, aromatic aminocarbonyl, aromatic diamino and aromatic oxydicarbonyl repeating units.

10 The LCP composed of the above described repeating units may include both of those give anisotropic melt phase and those do not, depending on structural components of the polymer and ratio and sequence distribution of the components. The LCP used for the present invention is limited to those exhibit anisotropic melt phase.

15 Examples of monomers which provide the aromatic oxycarbonyl repeating units are p-hydroxybenzoic acid, m-hydroxybenzoic acid, o-hydroxybenzoic acid, 6-hydroxy-2-naphthoic acid, 5-hydroxy-2-naphthoic acid, 3-hydroxy-2-naphthoic acid, 4'-hydroxybiphenyl-4-carboxylic acid, 3'-
20 hydroxybiphenyl-4-carboxylic acid, 4'-hydroxybiphenyl-3-carboxylic acid, and alkyl-, alkoxy- or halogen-substituted derivatives thereof as well as ester forming derivatives such as acyl derivatives, ester derivatives and acyl halide thereof. Among the above, p-hydroxybenzoic acid and 6-
25 hydroxy-2-naphthoic acid are preferable in terms of easier

control of the properties and the melting point of the resulting LCP.

Examples of monomers which provide the aromatic di-carbonyl repeating units are aromatic dicarboxylic acids such as terephthalic acid, isophthalic acid, 2,6-naphthalenedicarboxylic acid, 1,6-naphthalenedicarboxylic acid, 2,7-naphthalenedicarboxylic acid, 1,4-naphthalenedicarboxylic acid, 4,4'-dicarboxybiphenyl, and alkyl-, alkoxy or halogen-substituted derivatives thereof as well as ester forming derivatives such as ester derivatives, acid halide thereof. Among the above, terephthalic acid and 2,6-naphthalenedicarboxylic acid are preferable in terms of easier control of the mechanical properties, heat resistance, melting point and molding properties of the resulting LCP.

Examples of monomers which provide the aromatic dioxy repeating units are aromatic diols such as hydroquinone, resorcin, 2,6-dihydroxynaphthalene, 2,7-dihydroxynaphthalene, 1,6-dihydroxynaphthalene, 1,4-dihydroxynaphthalene, 4,4'-dihydroxybiphenyl, 3,3'-dihydroxybiphenyl, 3,4'-dihydroxybiphenyl, 4,4'-dihydroxybiphenyl ether, and alkyl-, alkoxy- or halogen-substituted derivatives as well as ester forming derivatives such as acyl derivatives thereof. Among the above, hydroquinone and 4,4'-dihydroxybiphenyl are

preferable in terms of the good reactivity during the polymerization process and the good properties of the resulting LCP.

5 Examples of monomers which provide the aromatic
aminooxy repeating units are aromatic hydroxyamines such as
p-aminophenol, m-aminophenol, 4-amino-1-naphthol, 5-amino-
1-naphthol, 8-amino-2-naphthol, 4-amino-4'-hydroxybiphenyl,
and alkyl-, alkoxy- or halogen-substituted derivatives as
well as ester forming derivatives such as acyl derivatives
10 thereof and amide forming derivatives such as N-acyl
derivatives thereof.

Examples of monomers which provide the aromatic
diamino repeating units are aromatic diamines such as p-
phenylenediamine, m-phenylenediamine, 1,5-
15 diaminonaphthalene, 1,8-diaminonaphthalene and alkyl-,
alkoxy- or halogen-substituted derivatives as well as amide
forming derivatives such as N-acyl derivatives thereof.

Examples of monomers which provide the aromatic
aminocarbonyl repeating units are aromatic aminocarboxylic
20 acids such as p-aminobenzoic acid, m-aminobenzoic acid, 6-
amino-2-naphthoic acid, and alkyl-, alkoxy- or halogen-
substituted derivatives as well as ester forming
derivatives such as acyl derivatives, ester derivatives and
acid halide thereof and amide forming derivatives such as
25 N-acyl derivatives thereof.

Examples of monomers which provide the aromatic oxydicarbonyl repeating units are hydroxy-aromatic dicarboxylic acids such as 3-hydroxy-2,7-naphthalenedicarboxylic acid, 4-hydroxyisophthalic acid, 5-hydroxyisophthalic acid, and alkyl-, alkoxy- or halogen-substituted derivatives thereof as well as ester forming derivatives such as acyl derivatives, ester derivatives and acyl halide thereof.

The LCP used for the present invention may have thioester bonding unless the bonding does not impair the object of the present invention. Examples of monomers which provide thioester bonding are mercapto-aromatic carboxylic acid, aromatic dithiol and hydroxy-aromatic thiol. The proportion of these additional monomers based on the total amount of monomers which provide aromatic oxycarbonyl, aromatic di-carbonyl, aromatic dioxy, aromatic aminooxy, aromatic diamino and aromatic oxy di-carbonyl repeating units is preferably equal to or less than 10 mol%.

Among the above, the preferred LCPs used for the present invention are those comprising aromatic oxycarbonyl repeating unit including 4-oxybenzoyl repeating unit and/or 6-oxy-2-naphthoyl repeating unit in view of the good mechanical properties of the resulting LCPs.

In a preferred embodiment, the molar proportion of the total amount of 4-oxybenzoyl and 6-oxy-2-naphthoyl

repeating units is 50-80 mol% based on the total repeating units in the LCP, in view of the good moldability and thermal stability of the resulting LCP.

5 Examples of the preferred LCPs comprising 4-oxybenzoyl and/or 6-oxy-2-naphthoyl repeating units may include:

- 1) 4-hydroxybenzoic acid/6-hydroxy-2-naphthoic acid copolymer,
- 2) 4-hydroxybenzoic acid/terephthalic acid/4,4'-
10 dihydroxybiphenyl copolymer,
- 3) 4-hydroxybenzoic acid/terephthalic acid/isophthalic acid/4,4'-dihydroxybiphenyl copolymer,
- 4) 4-hydroxybenzoic acid/terephthalic acid/isophthalic acid/4,4'-dihydroxybiphenyl/hydroquinone copolymer,
- 15 5) 4-hydroxybenzoic acid/terephthalic acid/hydroquinone copolymer,
- 6) 6-hydroxy-2-naphthoic acid/terephthalic acid/hydroquinone copolymer,
- 7) 4-hydroxybenzoic acid/6-hydroxy-2-naphthoic
20 acid/terephthalic acid/4,4'-dihydroxybiphenyl copolymer,
- 8) 6-hydroxy-2-naphthoic acid/terephthalic acid/4,4'-dihydroxybiphenyl copolymer,
- 9) 4-hydroxybenzoic acid/6-hydroxy-2-naphthoic acid/terephthalic acid/hydroquinone copolymer,
- 25 10) 4-hydroxybenzoic acid/2,6-naphthalene dicarboxylic

acid/4,4'-dihydroxybiphenyl copolymer,

11) 4-hydroxybenzoic acid/terephthalic acid/2,6-naphthalene dicarboxylic acid/hydroquinone copolymer,

12) 4-hydroxybenzoic acid/2,6-naphthalene dicarboxylic acid/hydroquinone copolymer,

13) 4-hydroxybenzoic acid/6-hydroxy-2-naphthoic acid/2,6-naphthalene dicarboxylic acid/hydroquinone copolymer,

14) 4-hydroxybenzoic acid/terephthalic acid/2,6-naphthalene dicarboxylic acid/hydroquinone/4,4'-dihydroxybiphenyl

copolymer,

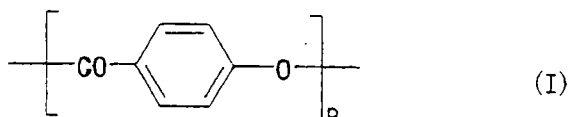
15) 4-hydroxybenzoic acid/terephthalic acid/4-aminophenol copolymer,

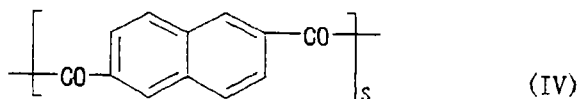
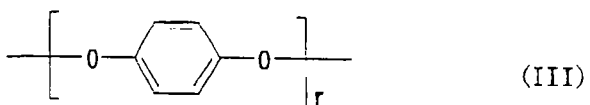
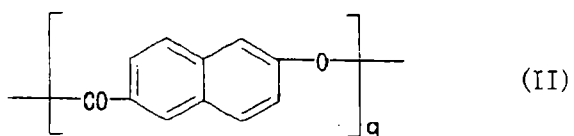
16) 6-hydroxy-2-naphthoic acid/terephthalic acid/4-aminophenol copolymer,

17) 4-hydroxybenzoic acid/6-hydroxy-2-naphthoic acid/terephthalic acid/4-aminophenol copolymer, and

18) 4-hydroxybenzoic acid/terephthalic acid/4,4'-dihydroxybiphenyl /4-aminophenol copolymer,

Among the above, copolymer of 13) is especially preferable in view of moldability and thermal stability of the polymer. As the copolymer of 13), a copolymer which satisfy the following formulae is preferably used:





wherein p, q, r and s represent molar proportion (mol %) of repeating units (I)-(IV) respectively in the LCP and satisfy the following formulae:

$$60 \leq p+q \leq 78$$

$$0.05 \leq q \leq 3$$

$$11 \leq r \leq 20$$

$$11 \leq s \leq 20$$

$$p+q+r+s=100$$

in view of the good thermal stability of the resulting LCP.

The LCP of the instant invention may be a polymer blend comprising two or more LCPs for the purpose of, for example, increasing flowability of the LCP composition when it is molded.

When a polymer blend is employed, the crystalline melting temperature of the polymer blend should be in the range of 310-410°C.

The LCP composition of the present invention is

provided by the above described LCP and glass fiber having a number average diameter of 4-8 μ m. LCP compositions obtained as above may include those having DTUL of 280-360°C as well as those having DTUL of less than 280°C or more than 360°C. According to the present invention, the LCP composition having a DTUL of 280-360°C, preferably 280-340°C and more preferably 280-320°C is used.

A LCP composition having a DTUL of less than 280°C does not exhibit enough thermal stability and may cause deformation or warpage due to the reflow soldering conducted at high temperatures. A LCP composition having a DTUL of more than 360°C usually has too high crystalline melting temperature and therefore, is not suit for molding the component.

In the specification and claims, the DTUL (deflection temperature under load) is the value determined according to the following method.

<Method for determining deflection temperature under load>

Test strip of the LCP composition with length of 127 mm, width of 3.2 mm, and thickness of 12.7 mm is molded using injection molding machine (UH 1000-110, Nissei Plastic Industrial Co., Ltd. Nagano, Japan). Deflection temperature is measured using the test strip according to ASTM D 648 under load of 1.82 MPa and heating rate of 2°C/min.

The method for preparing the LCP used for the present invention is not limited and any method known to the art can be employed. For example, conventional polycondensation methods such as molten acidolysis and slurry polymerization methods for preparing polymer to give ester and/or amide bondings among the above described monomer components may be employed.

The molten acidolysis method is preferably used for preparing the LCP. In this method, the monomers are heated to give molten solution and then the solution is reacted to give the molten polymer. The final step of this method may be carried out under vacuum to facilitate removing the volatile by-products such as acetic acid or water.

The slurry polymerization method is characterized in that monomers are reacted in a heat-exchange fluid to give solid state polymer in the form of suspension in the heat-exchange liquid medium.

In either of the molten acidolysis method or the slurry polymerization method, the polymerizing monomer may be in the form of lower acyl derivative obtained by acylating the hydroxyl group and/or amino group. The lower acyl group may have preferably 2-5, more preferably 2-3 carbon atoms. Acetylated monomers are most preferably used for the reaction.

The lower acyl derivatives of the monomers may be those prepared beforehand by acylating the monomers independently or may be those produced in the reaction system by adding an acylating agent such as acetic anhydride to the monomers upon preparing the LCP.

In either of the molten acidolysis method or the slurry polymerization method, a catalyst may be used in the reaction, if desired.

Examples of the catalysts include organic tin compounds such as dialkyl tin oxide (ex. dibutyl tin oxide) and diaryl tin oxide; organic titanium compounds such as titanium dioxide, antimony trioxide, alkoxy titanium silicate and titanium alkoxide; alkaline or alkaline earth metal salt of carboxylic acid such as potassium acetate; salts of inorganic acid (ex. K_2SO_4); Lewis acid (ex. BF_3) and gaseous acid catalysts such as halogenated hydrogen (ex. HCl).

When a catalyst is used, the amount of the catalyst added to the reaction based on the total amount of the monomers may preferably be 10-1000 ppm, and more preferably 20-200 ppm.

The LCP may be obtained from the polymerizing reaction vessel in molten state and then, processed to give pellets, flakes or powders.

The LCP in the form of pellet, flake or powder

may be, if desired, heated in substantially solid state under vacuum or an inert gas, such as nitrogen or helium, atmosphere. The temperature of the heat treatment is not specifically limited so long as the LCP is kept in the solid state and may be 260-350°C and preferably 280-320°C.

The LCP composition of the present invention may be obtained by adding glass fiber having a number average diameter of 4-8 μm to the LCP and melt kneading the mixture using a kneading machine such as Banbury mixer, kneader, single screw extruder, twin screw extruder or the like at a temperature of from near the crystalline melting temperature (T_m) to $T_m+30^\circ\text{C}$.

The glass fiber to be admixed with the LCP has a number average diameter of 4-8 μm and may have a cut length of 2-4mm. In order to provide a LCP composition comprising a glass fiber of the desired length, the condition of melt kneading is adjusted so that the number average length of the glass fiber in the resulting LCP composition is 100-200 μm , preferably, 130-200 μm .

The number average length of the glass fiber in the LCP composition obtained by melt kneading the LCP and the glass fiber is determined as follows.

<Method for determining the length of the glass fiber in the LCP composition>

The LCP composition comprising the glass fiber is

burned to ash. The remained glass fiber in the ash is dispersed well in a mixture of purified water and a surfactant. One milliliter (1 ml) of the dispersion is put on a glass plate and measure the length of the glass fiber in the dispersion is measured under microscope. In the examples and comparative examples of the instant application, a microscope BX60 (Olympus Corporation, Tokyo, Japan) was used to obtain image data of the dispersion and the image data was analyzed using the Image Analyzing Software WinRoof (Mitani Corporation, Tokyo, Japan) to determine the length of the glass fiber.

According to the present invention, the amount of the glass fiber in the LCP composition is preferably, 5-100 parts by weight, more preferably 10-80 parts by weight and especially 20-70 parts by weight per 100 parts by weight of the LCP.

The LCP composition of the present invention may further comprise an additional filler selected from fibrous, lamellar and powder fillers in addition to the glass fiber filler for the better mechanical or surface properties of the molded articles made of the LCP composition.

Examples of the fibrous fillers may include silica-alumina fiber, alumina fiber, carbon fiber, aramid fiber, potassium titanate fiber, aluminum borate fiber and wollastonite.

The average diameter of the additional fibrous filler used in the invention is not specifically limited unless it does not impair the object of the present invention and may preferably be 0.1-50 μ m. In the case of the cross section of the fibrous filler is not circle, the "diameter" represents the longest distance between two points around the cross section of the filler.

Examples of the lamellar and powder fillers may include mica, graphite, calcium carbonate, dolomite, clay, glass flake, glass beads, barium sulfate, titanium oxide and diatomite.

The total amount of the additional fillers in the LCP composition of the present invention may be 1-100 parts by weight, preferably 1-80 parts by weight and most preferably 1-60 parts by weight per 100 parts by weight of the LCP.

The LCP composition of the present invention may further comprise one or more additives that are conventionally used for resin compositions, unless they are not impair the object of the invention. For example, molding lubricant such as higher aliphatic acid, higher aliphatic ester, higher aliphatic amide, higher aliphatic acid metal salt, polysiloxane and fluorocarbon resin; colorant such as dyes and pigments; antioxidant; thermal stabilizer; UV absorbent; antistatic agent; and surface

active agent may be admixed.

Molding lubricants such as higher aliphatic acid, higher aliphatic ester, higher aliphatic acid metal salt or fluorocarbon-type surfactant may be added to the pellets of the LCP composition before subjecting the pellets to the molding process, so that the agent adhere to the outer surface of the pellet. The term "higher aliphatic" used herein refers to those having C10-C25 aliphatic moiety.

The fibrous, lamellar or powder filler and the additional component may be added to the LCP composition and melt kneading the mixture using a kneading machine such as Banbury mixer, kneader, single screw extruder, twin screw extruder or the like at a temperature of from around the crystalline melting temperature (T_m) to $T_m+30^\circ\text{C}$.

According to the present invention, the LCP composition comprising the additional fibrous, lamellar or powder filler and/or the additional components in addition to the glass fiber filler must have DTUL within the range of $280-360^\circ\text{C}$.

Thus obtained LCP composition having a DTUL of $280-360^\circ\text{C}$ which comprises: 100 parts by weight of a wholly aromatic liquid crystalline polymer having a crystalline melting temperature of $310-410^\circ\text{C}$, and 5-100 parts by weight of a glass fiber having a number average diameter of $4-8\mu\text{m}$ and a number average length of $100-200\mu\text{m}$ is then molded

using a conventional method such as injection molding, compression molding, extrusion molding and blow molding to give a desired surface mount type electronic component.

5 Examples of the surface mount type electronic components provided by the present invention include switches, relays, connectors, condensers, coils, trans, camera modules, antenna and chip antenna.

10 The electronic component of the present invention is suitably soldered on the surface of a substrate such as a circuit board with a cream solder comprising a solder alloy and a flux. The electronic component of the invention invites less flux migration even if it is soldered with a lead free cream solder whose melting point is as high as 200-250°C. Even if heated to such a high
15 temperature, the electronic component of the invention develops no or only small warpage and therefore, causes less flux migration problem.

20 The cream solders suitably used for soldering the electronic component of the invention on the surface of a substrate such as a circuit board are described as follows.

The cream solders may be any of those conventionally used for surface mounting electronic components. Examples of solder alloys comprised in the cream solders may include lead-free solder alloys such as
25 Sn-Ag-Cu, Sn-Ag, Sn-Cu, Sn-Ag-Cu-Bi, Sn-Ag-Bi-In, Sn-Cu-Ni,

Sn-Bi and Sn-Zn, and Pb-containing solder alloys such as Sn-Pb eutectic solder. Those solder alloys may be comprised solely or in combination of two or more in the cream solder.

5 Among the solder alloys, lead-free solder alloys are preferably used in view of the restriction for using lead under RoHS in EU. Among said lead-free solder alloys, Sn-Ag-Cu alloy is more preferably used in view of its excellent heat and fatigue resistances.

10 The cream solder used in the present invention comprises a solder alloy and a flux. The flux may comprise a resin which is the base of the flux and activating agent, organic halogenated compound, thixotropic agent and organic solvent.

15 In addition to the above ingredients, the flux may further comprise one or more optional additives including antioxidant, anticorrosion agent, chelating agent, leveling agent, antifoaming agent, dispersing agent, frosting agent, and colorant, if desired.

20 Examples of the resins in the flux may include natural resins such as natural rosin, disproportionated rosin, polymerized rosin and hydrogenated rosin; and synthetic resins such as polyester, polyurethane, silicone, epoxy, oxetane, and acrylic resins. These resins may be
25 used solely or in combination of two or more.

Examples of the activating agent in the flux may include salt of an amine compound such as methylamine, ethylamine, n-propylamine, isopropylamine, n-butylamine, dimethylamine, diethylamine, di-n-propylamine, diisopropylamine, di-n-butylamine, trimethylamine, triethylamine, tri-n-propylamine, triisopropylamine, monoethanolamine, diethanolamine or triethanolamine; and an acid such as a halogenated hydrogen such as hydrochloric acid and hydrobromic acid, or a carboxylic acid such as oxalic acid, malonic acid, succinic acid, adipic acid, glutaric acid, diethylglutaric acid, pimelic acid, azelaic acid, sebacic acid, maleic acid, fumaric acid, diglycolic acid, caprylic acid, lauric acid, myristic acid, palmitic acid, linoleic acid, oleic acid, stearic acid, arachic acid, behenic acid, linolenic acid, benzoic acid, hydroxypivalic acid, dimethylolpropionic acid, citric acid, malic acid, glyceric acid and lactic acid. The activating agents may be used solely or in combination of two or more.

The flux of the cream solder used in the present invention may preferably comprise less than 30wt% of the activating agent based on the total amount of the flux.

The organic halogenated compound contained in the flux may be a compound comprising chlorine, bromine or iodine. Examples of organic halogenated compounds may include halogenated alcohols such as 3-bromo-1-propanol and

1,4-dibromo-2-butanol, halogenated aliphatic carboxylate esters such as ethyl bromoacetate, ethyl α -bromocaprylate, ethyl α -bromopropionate, ethyl β -bromopropionate, methyl 9,10,12,13,15,16-hexabromostearate; halogenated aliphatic carboxylic acids such as 2,3-dibromo succinic acid and 9,10,12,13,15,16-hexabromostearic acid; halogenated benzyls such as 4-stearoyloxybenzyl bromide and 4-stearoylaminobenzyl bromide; halogenated alkylamides such as bis(2,3-dibromopropyl)-o-phthalamide, N,N,N',N'-tetra(2,3-dibromopropyl) succinamide; halogenated hydrocarbons such as 1-bromo-3-methyl-1-buten, 2,2-bis[4-(2,3-dibromopropyl)-3,5-bromophenyl]propane; halogenated ethers such as bis(2,3-dibromopropyl)glycerol and trimethylolpropane bis(2,3-dibromopropyl)ether; halogenated ketones such as 2,4-dibromoacetophenone; halogenated ureas such as N,N'-bis(2,3-dibromopropyl)urea; halogenated sulfones such as α,α,α -tribromomethyl sulfone; succinates such as bis(2,3-dibromopropyl)succinate; and isocyanurates such as tris(2,3-dibromopropyl)isocyanurate. The organic halogenated compounds may be used solely or in combination of two or more.

The flux of the cream solder used in the present invention may preferably comprise equal to or less than 20wt% of the organic halogenated compound based on the total amount of the flux.

Examples of the thixotropic agents contained in the flux may include polyolefin waxes such as castor wax; fatty acid amides such as m-xylylene bisstearamide; substituted urea waxes such as N-butyl-N'-stearyl urea; 5 polymers such as polyethyleneglycol, polyethylene oxide, methylcellulose, ethylcellulose and hydroxyethylcellulose; and inorganic particles such as silica and kaolin. These thixotropic agents may be used solely or in combination of two or more.

10 The flux of the cream solder used in the present invention may preferably comprise equal to or less than 30wt% of the thixotropic agent based on the total amount of the flux.

Examples of the organic solvents contained in the 15 flux may include triethyleneglycol monomethylether, triethyleneglycol dimethylether, tetraethyleneglycol dimethylether, diethyleneglycol monomethylether, diethyleneglycol monobutylether, diethyleneglycol monohexylether, ethyleneglycol monophenylether, 20 diethyleneglycol monophenylether, diethyleneglycol monobutyl acetate, dipropyleneglycol, diethyleneglycol-2-ethylhexylether, α -terpineol, benzylalcohol, 2-hexyldecanol, butylbenzoate, diethyl maleate, diethyl adipate, diethyl sebacate, dibutyl sebacate, dibutyl phthalate, dodecane, 25 tetradecene, dodecylbenzene, ethyleneglycol,

diethyleneglycol, dipropyleneglycol, triethyleneglycol,
hexyleneglycol, 1,5-pentanediol, methylcarbitol,
butylcarbitol, propyleneglycol monomethylether acetate,
propyleneglycol monoethylether acetate, butylcarbitol
5 acetate, 3-methoxybutyl acetate, triethyleneglycol
butylmethylether, and triacetin. These organic solvents
may be used solely or in combination of two or more.

The flux of the cream solder used in the present
invention may preferably comprise equal to or less than
10 50wt% of the organic solvent based on the total amount of
the flux.

The above described cream solder is applied to a
substrate such as a circuit board, electronic components of
the invention are mounted on the substrate, and then, fixed
15 by heating the substrate in a reflow soldering device to
effect soldering.

According to the present invention, the reflow
soldering device used in the reflowing step may be any of
those conventionally used for surface mounting electronic
20 component on the circuit board including infrared reflow
soldering device and forced-air convection reflow soldering
device.

The temperature of the reflow soldering step may
be determined according in the conventional manner.

25 The electronic component of the invention

develops less warpage even after reflow soldering at higher temperatures and therefore, can be mounted on the surface of a substrate with a lead-free solder causing no or less flux migration.

5 The present invention is further described in reference to the following Examples. The following examples are intended to illustrate the invention and are not to be construed to limit the scope of the invention.

10 In the examples and comparative examples below, following abbreviations are used.

POB: 4-hydroxybenzoic acid

BON6: 6-hydroxy-2-naphthoic acid

NDA: 2,6-naphthalene dicarboxylic acid

HQ: hydroquinone

15 TPA: terephthalic acid

Glass Fibers/additional fillers

GF1: glass fiber T-790 (Nippon Electric Glass Co. Ltd., Shiga, Japan), number average diameter: 6 μ m, cut length: 3mm.

20 GF2: glass fiber PX-1 (Asahi Fiber Glass Co., Ltd., Tokyo, Japan), number average diameter: 10 μ m, number average length: 20 μ m/70 μ m

GF3: glass fiber FT591 (Asahi Fiber Glass Co., Ltd., Tokyo, Japan), number average diameter: 13 μ m, cut length: 3mm

25 AB: aluminum borate fiber YS3A (Shikoku Chemicals

Corporation, Kagawa, Japan) diameter: 0.5-1.0 μ m, average length: 10-30 μ m

Synthesizing Example 1:LCP 1

POB 234.8 kg (1699 moles), BON6 0.9kg (5 moles),
5 HQ 38.3kg (348 moles), NDA 75.2 kg (348 moles) and acetic
anhydride 254.3 kg (2491 moles) were fed in a 0.5 m³
polymerization container made of SUS equipped with an
agitating device and a heat exchanger. Under nitrogen gas
atmosphere, the mixture was heated from the room
10 temperature to 145°C over 1 hour and kept at the
temperature for 0.5 hour. Then the mixture was heated to
348°C over 8 hours with distilling out the by-product,
acetic acid and polymerized at the temperature for 30
minutes, then the pressure in the polymerization container
15 was reduced from the atmospheric pressure to 20 torr over
70 minutes. The reaction was further conducted for more 30
minutes at the pressure. Thirty minutes after, the torque
of the reaction became the predetermined level and the
polymerization container was sealed. The reaction was
20 terminated by inducing nitrogen gas to the container so
that the pressure in the container was increased to 0.1MPa.
The valve at the bottom of polymerization container was
opened and the content of the container was pulled out
through a dice to give strands of the prepolymer, i.e.
25 liquid crystalline polymer with low polymerization degree

and the prepolymer was cut to give pellets.

The crystalline melting temperature of the prepolymer determined by differential scanning calorimetry was 331°C and the melt viscosity was 16 Pa.s.

5 Pellets of thus obtained prepolymer 10kg were fed
in the vessel of a 40L-tumble dryer made by SUS. The gas
phase in the vessel was kept at 200°C. After the gas phase
was exchanged by nitrogen gas, the vessel was rotated at
15rpm under nitrogen gas flow of 120 L/hour and the
10 temperature in the vessel was increased to 290°C over 1
hour while kept the pellets in the solid state. The solid
phase polymerization was effected at the temperature for 5
hours. After the reaction was completed, the vessel was
cooled and stopped rotating, and the pellet of LCP 1 was
15 obtained.

The crystalline melting temperature of the LCP 1
was 333°C.

Synthesizing Example 2: LCP2

20 POB 195.9kg (1416.8 moles), BON6 7.6kg (40.5
moles), HQ 31.2kg (283.4 moles), NDA 61.3kg (283.4 moles)
and acetic anhydride 212.8kg (2084.8 moles) were fed in a
0.5 m³ polymerization container made of SUS equipped with
an agitating device and a heat exchanger. Under nitrogen
gas atmosphere, the mixture was heated from the room
25 temperature to 145°C over 1 hour and kept at the

temperature for 0.5 hour. Then the mixture was heated to 348°C over 8 hours with distilling out the by-product, acetic acid and polymerized at the temperature for 30 minutes, then the pressure in the polymerization container was reduced from the atmospheric pressure to 20 torr over 70 minutes. The reaction was further conducted for more 60 minutes at the pressure. Sixty minutes after, the torque of the reaction became the predetermined level and the polymerization container was sealed. The reaction was terminated by inducing nitrogen gas to the container so that the pressure in the container was increased to 0.1MPa. The valve at the bottom of polymerization container was opened and the content of the container was pulled out through a dice to give strands of the liquid crystalline polymer and then they were cut to give pellets of LCP 2.

The crystalline melting temperature of the LCP 2 determined by differential scanning calorimetry was 323°C.

Synthesizing Example 3: LCP 3

POB 149.8kg (1084.9 moles), BON6 74.9kg (398.2 moles), HQ 57.6kg (523.5 moles), TPA 87.0kg (523.5 moles) and acetic anhydride 266.0kg (2606.0 moles) were fed in a 0.5 m³ polymerization container made of SUS equipped with an agitating device and a heat exchanger. Under nitrogen gas atmosphere, the mixture was heated from the room temperature to 145°C over 1 hour and kept at the

temperature for 0.5 hour. Then the mixture was heated to 348°C over 8 hours with distilling out the by-product, acetic acid. Then, the pressure in the polymerization container was reduced from the atmospheric pressure to 10 torr over 120 minutes at the same temperature. The reaction was further conducted for more 90 minutes at the pressure. Ninety minutes after, the torque of the reaction became the predetermined level and the polymerization container was sealed. The reaction was terminated by inducing nitrogen gas to the container so that the pressure in the container was increased to 0.1MPa. The valve at the bottom of polymerization container was opened and the content of the container was pulled out through a dice to give strands of the liquid crystalline polymer and then they were cut to give pellets of LCP 3.

The crystalline melting temperature of the LCP3 determined by differential scanning calorimetry was 330°C.

Examples 1-4 and Comparative Examples 1-4

Preparation of LCP composition

LCPs and fillers shown in Table 1 were mixed using a Henschel mixer and then, kneaded using a twin screw extruder (TEX30 α -35BW-2V, The Japan Steel Works, LTD., Tokyo, Japan) to give LCP compositions in the form of pellets.

The number average length of the glass fiber

contained in the LCP composition and the DTUL of the LCP composition under ASTM D648 were determined and shown in Table 2.

Flux migration test

5 Thus obtained LCP compositions were dried for 4 hours at 150°C, and then molded using an injection molding machine (α -100iA, Funac. Ltd. Yamanashi, Japan) at a cylinder temperature of 360°C and a die temperature of 90°C to give a test piece with a metal terminal (B) inserted in
10 the resin part (A). The size of the resin part (A) of the test piece was 15mm x 15mm x 1 mm. The precise shape and size of the test piece is shown in Figures 1-1 and 1-2. The numerical values in the figure represent the size in mm.

 On a substrate, cream solder (M705-GRN360-K2-V, solder alloy: Sn-Ag-Cu, melting point of the alloy: 219°C, Senju Metal Industry Co., Ltd., Tokyo, Japan) was put, the
15 test piece with metal terminal was mounted, and fixed thereon by reflow soldering the same using a infrared reflow soldering machine (SAI-2604M, Senju Metal Industry, Co., Ltd, Tokyo, Japan). The reflow soldering cycle
20 included 70 seconds at temperatures in the range of 200-260°C and 40 seconds at temperatures in the range of 230-260°C (peak temperature was 260°C). Two reflow soldering cycles were conducted. After that, the substrate with the
25 test piece was left to cool to the room temperature.

The test piece mounted on the substrate was broken with nipper or plyer so that the LCP composition was removed from the metal terminal. The metal terminal was then visually observed to see whether or not the flux migration was occurred. The number of the test pieces on which flux migration was observed was out of 20 test pieces was counted. The ratio of the test pieces with flux migration is shown in Table 2.

Warpage development test

Connector test pieces having the shape and size shown in Figures 2-1 and 2-2 were prepared under the same condition as above. The numerical values in the figure 2-1 represent the size in mm.

Thus obtained connector test pieces were soldered on a substrate using the same cream solder under the same reflow soldering condition as above. After the two cycle reflow soldering was completed, the substrate with the connector was left to cool to the room temperature. After that, the height of the 4 corners of the connector test pieces were measured with a coordinate measuring machine (QVH250pro, Mitsutoyo Corporation, Kanagawa, Japan) to determine flatness of the test piece. Results are shown in Table 2.

Table 1

	LCP		Filler	
		parts by weight		parts by weight
Ex.1	LCP1	100	GF1	42.8
Ex.2	LCP1	100	GF1	53.8
Ex.3	LCP1	100	GF1	66.7
Ex.4	LCP2	100	GF1	53.8
Com.Ex.1	LCP1	100	GF2 (20 μ m)	42.8
Com.Ex.2	LCP1	100	GF2 (70 μ m)	66.7
Com.Ex.3	LCP2	100	AB	42.8
Com.Ex.4	LCP2	100	GF3	42.8
Com.Ex.5	LCP3	100	GF1	53.8

Table 2

	filler diameter* ¹ (μ m)	filler length* ² (μ m)	DTUL (°C)	flux migration (%)	flatness
Ex.1	6	147	310	0	0.02
Ex.2	6	152	311	0	0.02
Ex.3	6	192	312	0	0.01
Ex.4	6	145	288	0	0.02
Com.Ex.1	10	15	286	25	0.04
Com.Ex.2	10	58	280	15	0.04
Com.Ex.3	0.7	20	280	45	0.05
Com.Ex.4	13	143	285	30	0.04
Com.Ex.5	6	136	252	15	0.04

*1: number average diameter, *2: number average length

As is apparent from the results shown in Table 2, the electronic components made of a LCP composition whose DTUL is 280-360°C comprising a glass fiber having a number average diameter of 6 μ m and a number average length of 100-200 μ m caused no flux migration and only small warpage when soldered using a cream solder.

WHAT IS CLAIMED IS:

1. A surface mount type electronic component which is obtained by molding a liquid crystalline polymer composition comprising:

5 100 parts by weight of a wholly aromatic liquid crystalline polymer having a crystalline melting temperature of 310-410°C, and

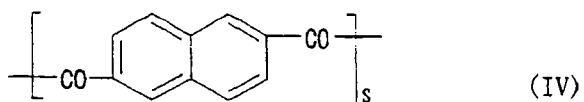
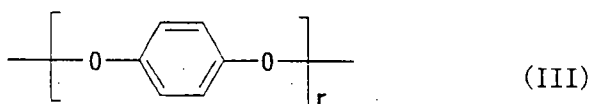
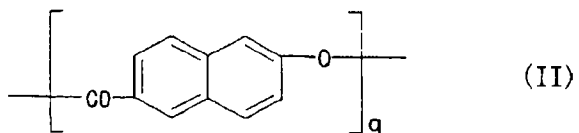
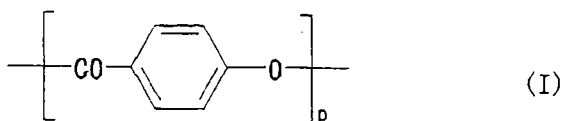
10 5-100 parts by weight of a glass fiber having a number average diameter of 4-8 μ m and a number average length of 100-200 μ m,

wherein the LCP composition has a deflection temperature under load (DTUL) of 280-360°C.

2. The electronic component according to Claim 1, wherein the wholly aromatic liquid crystalline polymer
15 comprises 4-oxybenzoyl and/or 6-oxy-naphthoyl repeating units.

3. The electronic component according to Claim 2, wherein the total amount of 4-oxybenzoyl and 6-oxy-naphthoyl repeating units based on the total repeating
20 units in the liquid crystalline polymer is 50-80mol%.

4. The electronic component according to Claim 3, wherein the liquid crystalline polymer is consisting of the repeating units shown by the formulae [1]-[4]:



wherein p, q, r and s represent molar proportion (mol %) of repeating units (I)-(IV) respectively in the polymer and satisfy the following formulae:

$$60 \leq p+q \leq 78$$

$$0.05 \leq q \leq 3$$

$$11 \leq r \leq 20$$

$$11 \leq s \leq 20$$

$$p+q+r+s=100.$$

5. The electronic component according to Claim 1, which is to be soldered with a lead-free solder having a melting point of 200-250°C on the surface of a substrate.

6. The electronic component according to any one of Claims 1-5, which is selected from the group consisting of connector, switch, relay, condenser, coil, trans, camera module, antenna and chip antenna.

7. A liquid crystalline polymer composition for manufacturing a surface mount type electronic component, which comprises:

100 parts by weight of a wholly aromatic liquid crystalline polymer having a crystalline melting temperature of 310-410°C, and

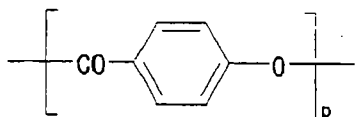
5-100 parts by weight of a glass fiber having a number average diameter of 4-8μm and a number average length of 100-200μm;

wherein the LCP composition has a deflection temperature under load (DTUL) of 280-360°C.

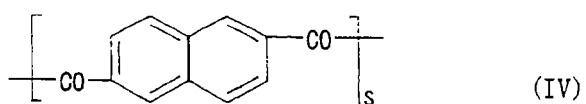
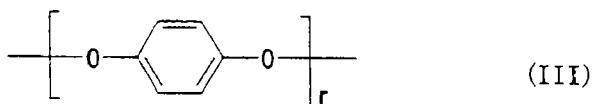
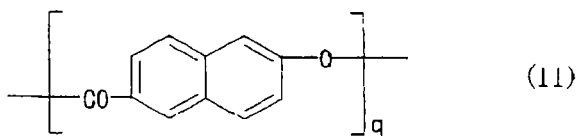
8. The composition according to Claim 7, wherein the wholly aromatic liquid crystalline polymer comprises 4-oxybenzoyl and/or 6-oxy-naphthoyl repeating units.

9. The composition according to Claim 8, wherein the total amount of 4-oxybenzoyl and 6-oxy-naphthoyl repeating units based on the total repeating units in the polymer is 50-80mol%.

10. The composition according to Claim 9, wherein the liquid crystalline polymer is consisting of the repeating units shown by the formulae [1]-[4]:



(I)



wherein p, q, r and s represent molar proportion (mol %) of repeating units (I)-(IV) respectively in the polymer and satisfy the following formulae:

$$60 \leq p+q \leq 78$$

$$0.05 \leq q \leq 3$$

$$11 \leq r \leq 20$$

$$11 \leq s \leq 20$$

$$p+q+r+s=100.$$

11. A method for mounting an electronic component according to Claim 1 on a circuit board, which comprises the step of soldering the component on the surface of the board using a cream solder which comprises a solder alloy and a flux.

12. The method according to Claim 11, wherein the solder alloy is a lead-free solder alloy having a melting point of 200-250°C.