

LIQUID CRYSTAL SEALANT AND LIQUID CRYSTAL DISPLAY CELL USING
SAME

TECHNICAL FIELD

The present invention relates to a liquid crystal sealant that is cured by light and/or heat, and used in a liquid crystal one-drop fill process. More specifically, the present invention relates to a liquid crystal sealant for use in a liquid crystal one-drop fill process, which has low liquid crystal contamination and good storage stability.

BACKGROUND ART

The so-called liquid crystal one-drop fill process that has a higher mass productivity was proposed as a method of manufacturing a liquid crystal display cell with an increased size of the liquid crystal display cell in recent years (Patent documents 1 and 2). The liquid crystal one-drop fill process is specifically a method of manufacturing a liquid crystal display cell by dropping liquid crystal into the inside of a weir of a liquid crystal sealant formed on one substrate, and then bonding the other substrate whereby to seal the liquid crystal.

However, the liquid crystal one-drop fill process has problems that the liquid crystal sealant in the uncured state is in contact with the liquid crystal, and thus components of the liquid crystal sealant at this time are dissolved into the liquid crystal (elution) and the resistance value of the

liquid crystal decreases, and display defects are generated in the vicinity of the seal.

In order to resolve this problem, a light-heat combination type liquid crystal sealant is currently used as a liquid crystal sealant for use in the liquid crystal one-drop fill process, and practically applied (Patent documents 3 and 4). A liquid crystal one-drop fill process using this liquid crystal sealant is characterized by irradiating the liquid crystal sealant interposed between substrates with light to perform first curing, and then performing secondary curing by heating. According to this method, it is possible to promptly cure uncured liquid crystal sealant with light and suppress dissolution (elution) of components of the liquid crystal sealant into the liquid crystal. Furthermore, with only photocuring, problems such as insufficient adhesive strength from curing shrinkage at the time of the photocuring and the like are generated. However, the light-heat combination type has an advantage that stress relaxation effects can be obtained by the secondary curing by heating, and thus such problems can be solved.

However, with the decrease in size of liquid crystal display devices in recent years, a light-shielded part where light does not reach is caused in a liquid crystal sealant by the metal wiring of an array substrate or by the black matrix part of a color filter substrate of a liquid crystal display device, and thus the problem of display defects in the vicinity of the seal becomes more serious than before. In

other words, due to the presence of the light-shielded part, the first curing by light is insufficient, and uncured components remain in large quantities in the liquid crystal sealant. If the secondary curing process by heat proceeds in this state, it leads to results that dissolution of the uncured components into the liquid crystal is promoted by this heat, and display defects are caused in the vicinity of the seal.

In order to resolve this problem, a method to improve the reactivity of the curable resin, and advance the curing before dissolution into the liquid crystal is very useful. Thus, various investigations to improve thermal reactivity have been conducted. There was a trial to react a liquid crystal sealant not sufficiently cured by light in the light-shielded part quickly at a low temperature, whereby to suppress contamination of the liquid crystal. For example, Patent documents 5 and 6 disclose methods using thermal radical initiators. In addition, Patent document 7 discloses methods using polyvalent carboxylic acids as a curing accelerator.

However, it is difficult to say that addition of such thermal radical initiator and curing accelerator, such as a polyvalent carboxylic acid, can sufficiently realize low liquid crystal contamination since such thermal radical initiator and curing accelerator themselves elute into liquid crystal. In addition, these components result in an effect of accelerating the reaction speed, and reversely, involve the disadvantage of poor storage stability.

As described above, development of the liquid crystal sealant for use in the liquid crystal one-drop fill process has been very intensively performed, but a liquid crystal sealant realizing low liquid crystal contamination, and having good storage stability as well has not yet been realized.

Patent Document 1: Japanese Unexamined Patent Application, Publication No. S63-179323

Patent Document 2: Japanese Unexamined Patent Application, Publication No. H10-239694

Patent Document 3: Japanese Patent Publication No. 3583326

Patent Document 4: Japanese Unexamined Patent Application, Publication No. 2004-61925

Patent Document 5: Japanese Unexamined Patent Application, Publication No. 2004-126211

Patent Document 6: Japanese Unexamined Patent Application, Publication No. 2009-8754

Patent Document 7: PCT International Publication No. WO2008/004455

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

The present invention relates to a light- or heat-curable liquid crystal sealant for use in the liquid crystal one-drop fill process, the liquid crystal sealant enabling increased resolution, faster response, lower-voltage driving, and longer service life of liquid crystal display elements due to having

extremely low tendency to contaminate liquid crystal, and also having extremely good working efficiency due to having excellent storage stability.

Means for Solving the Problems

The present inventors found that a liquid crystal sealant that contains a compound having one or more each of an acryloyl group and a methacryloyl group in each molecule thereof can resolve the problems, and completed the present invention.

Specifically, the present invention relates to the following (1) to (14). Meanwhile, in the specification, when "(meth)acrylic" is described, it means either one or both of "acrylic" and "methacrylic". Likewise, when "(meth)acrylate" is described, it means either one or both of "acrylate" and "methacrylate", and when "(meth)acryloyl" is described, it means either one or both of "acryloyl" and "methacryloyl".

(1)

A liquid crystal sealant for use in the liquid crystal one-drop fill process containing (A) a curable resin and (B) a heat-curing agent, in which the component (A) contains (a) a compound having one or more each of an acryloyl group and a methacryloyl group in each molecule thereof.

(2)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to (1), in which the component (a) is a compound that also has a hydrogen bond functional

group in the molecule.

(3)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to (2), in which the hydrogen bond functional group is a hydroxy group or an amide group.

(4)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of (1) to (3), in which the component (a) is either one or both of (a-1) a reaction product of glycidyl methacrylate and acrylic acid, and (a-2) a reaction product of the (a-1) and an isocyanate compound.

(5)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to (4), in which the isocyanate compound is a diisocyanate compound.

(6)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to (4) or (5), in which the isocyanate compound is tolylene diisocyanate.

(7)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to (4), in which the component (a) is a mixture of the component (a-1) and the component (a-2).

(8)

The liquid crystal sealant for use in the liquid crystal

one-drop fill process according to any one of (1) to (7), in which the component (A) contains the component (a) in 60% by mass or more.

(9)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of (1) to (8), in which the content of the component (A) in the total mass of the liquid crystal sealant is 40% to 90% by mass.

(10)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of (1) to (9), further containing (C) a silane coupling agent.

(11)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of (1) to (10), further containing (D) an inorganic filler.

(12)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of (1) to (11), further containing (E) a thermal radical polymerization initiator.

(13)

The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of (1) to (12), further containing (F) a photo-radical polymerization initiator.

(14)

A liquid crystal display cell sealed with a cured product obtained by curing the liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of (1) to (13).

Effects of the Invention

The liquid crystal sealant of the present invention has extremely low influence on the display properties of the liquid crystal, and thus allows increased resolution, fast response, lower voltage driving and longer service life of liquid crystal display elements, and, furthermore is excellent in terms of storage stability, and thus contributes to easy manufacture of a liquid crystal display cell. In addition, the liquid crystal sealant of the present invention is excellent in terms of properties of a cured material such as adhesive strength, and thus can realize manufacture of liquid crystal display elements having high reliability.

PREFERRED MODE FOR CARRYING OUT THE INVENTION

The liquid crystal sealant of the present invention contains (A) a curable resin, and the curable resin contains (a) a compound having one or more each of an acryloyl group and a methacryloyl group in each molecule thereof.

In this compound, the moiety of the acryloyl group contributes to good reactivity, and the moiety of the methacryloyl group contributes to storage stability. Specifically, the molecule is early crosslinked by light or by

heat due to quickness of the reactivity of the acryloyl group, and thus it is possible to suppress elution to the liquid crystal. In addition, on the other hand, due to the methacryloyl group contained in the molecule, it is possible to suppress a too fast curing reaction and damage to storage stability therefrom. In addition, the methacryloyl group proceeds with the crosslinking gently, and thus suppresses curing shrinkage, and improves properties of the cured product, such as adhesive strength.

The component (a), which is a compound having one or more each of an acryloyl group and a methacryloyl group in each molecule thereof, may be obtained, for example, by a reaction of glycidyl methacrylate and acrylic acid, a reaction of glycidyl methacrylate and an acrylic resin having a hydroxy group (for example, 2-hydroxy ethyl acrylate and the like), an esterification reaction of methacrylic acid and an acrylic resin having a hydroxy group, an esterification reaction of acrylic acid and a methacrylic resin having a hydroxy group (for example, 2-hydroxy ethyl methacrylate and the like) and the like. In addition, the component (a) may also be obtained by bonding reaction via isocyanate of an acrylic resin having a hydroxy group and a methacrylic resin having a hydroxy group, or a methacrylic resin having a hydroxy group and an acrylic resin having a hydroxy group, that is, a urethanation reaction. Furthermore, when the compound has a hydroxy group in the molecule, such as a reaction product of glycidyl methacrylate and acrylic acid, the molecules may be also bonded to each

other, or to another acrylic resin and methacrylic resin via the urethane bond.

The component (a) is preferably a compound that also has a hydrogen bond functional group in the molecule. Examples of the hydrogen bond functional group include a hydroxy group, an amino group, an amide group, a thiol group and the like. Furthermore, those having either one or both of a hydroxy group and an amide group are very suitable. From this viewpoint, a reaction product of glycidyl methacrylate and acrylic acid, a compound having a urethane bond, and the like are suitably used among the examples of the compounds as the component (a).

Furthermore, the component (a) is particularly preferably (a-1) the reaction product of glycidyl methacrylate and acrylic acid, or (a-2) the reaction product of the (a-1) and an isocyanate compound, and most preferably a mixture of the component (a-1) and the component (a-2).

The isocyanate is not particularly limited as long as it has an isocyanate group, and examples thereof may include 2-methacryloyloxyethyl isocyanate, 2-methyl methaphenylene diisocyanate, tolylene-2,4-diisocyanate, isophorone diisocyanate, 1,3-phenylene diisocyanate, 1,4-phenylene diisocyanate, hexamethylene diisocyanate, 5-chloro-2,4-toluene diisocyanate, 3,3'-dimethoxy-4,4'-biphenylene diisocyanate, dicyclohexylmethine-4,4'-diisocyanate, 4,4'-diisocyanate 3,3'-dimethyldiphenylmethane, meth-xylylene diisocyanate, 4,4'-methylene-bis(phenylisocyanate), tolylene-2,5-diisocyanate,

1,12-diisocyanate dodecane, 4,4'-methylene bis(2-chlorophenylisocyanate), 1,5-naphthalene diisocyanate, trimethyl-hexamethylene diisocyanate, 3,3'-dichlorodiphenyl-4,4'-diisocyanate, 1,4-cyclohexane diisocyanate, 1,5-diisocyanate 2-methyl pentane, 1,4-diisocyanate butane, 1,3-bis(isocyanatemethyl)cyclohexane, 1-chloromethyl-2,4-diisocyanate benzene, 2,2-bis(4-isocyanatephenyl)hexafluoropropanemethane diisocyanate, 1,8-diisocyanate octane, oxybis(4-phenylisocyanate), 2,4,6-trimethyl-1,3-phenylene diisocyanate and 2,4'-methylene bis(phenylene isocyanate). Among them, the isocyanate is preferably a diisocyanate compound such as isophorone diisocyanate, hexamethylene diisocyanate, tolylene-2,4-diisocyanate, tolylene-2,5-diisocyanate, and further preferably tolylene-2,4-diisocyanate or tolylene-2,5-diisocyanate. These isocyanates are available from the market as commercial products, for example, tolylene diisocyanate (CORONATE: manufactured by NIPPON POLYURETHANE INDUSTRY CO., LTD.) and the like.

Specific examples of the compound of the component (a) are shown in Tables 1 to 3 described below, but are not limited thereto as long as it is a compound having one or more each of an acryloyl group and a methacryloyl group in each molecule thereof.

[Table 1]

Compound No.	Structural formula
1	
2	
3	
4	

[Table 2]

Compound No.	Structural formula
5	
6	
7	

[Table 3]

Compound No.	Structural formula
8	
9	
10	
11	

The component (A) contains the component (a) preferably in 60% by mass or more, and further preferably in 70% by mass or more from the viewpoint of the content of the component (a). If the content of the component (a) is too small, the effects of the present invention, specifically, the property of a balance between realization of low liquid crystal contamination by the reactivity and storage stability cannot be sufficiently obtained.

In addition, the remainder besides the component (a) in the component (A) is an epoxy resin, a (meth)acrylic resin and the like, or a mixture thereof not corresponding to the

component (a). Any of these curable resins preferably has low contamination and solubility with respect to the liquid crystal, and suitable examples of the epoxy resin include a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, a phenol novolak type epoxy resin, a cresol novolak type epoxy resin, a bisphenol A novolak type epoxy resin, a bisphenol F novolak type epoxy resin, an alicyclic epoxy resin, an aliphatic chain-like epoxy resin, a glycidyl ester type epoxy resin, a hydantoin type epoxy resin, an isocyanurate type epoxy resin, a triphenol methane skeleton-containing phenol novolak type epoxy resin, and in addition, a diglycidyl ether of bifunctional phenols, a diglycidyl ether of bifunctional alcohols, and a halogenated material thereof, a hydrogenated material thereof and the like, but are not limited thereto.

The (meth)acrylic resin is suitably an epoxy (meth)acrylate that may be obtained by a well-known reaction of an epoxy resin and a (meth)acrylic acid. In addition, in this case, all of the epoxy groups may be (meth)acrylated, or a portion of them may be (meth)acrylated. The epoxy (meth)acrylate may be obtained, for example, by adding, a (meth)acrylic acid, a catalyst (for example, benzyldimethyl amine, triethyl amine, benzyltrimethyl ammonium chloride, triphenyl phosphine, triphenyl stibine and the like), and a polymerization inhibitor (for example, methoquinone, hydroquinone, methyl hydroquinone, phenothiazine, dibutyl hydroxytoluene and the like) in a prescribed equivalent ratio

to an epoxy resin, and performing esterification reaction, for example, at 80 to 110°C. The epoxy resin, which is a raw material, is not particularly limited, but is preferably a bi-functional or higher-functional epoxy resin, and examples thereof include a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, a phenol novolak type epoxy resin, a cresol novolak type epoxy resin, a bisphenol A novolak type epoxy resin, a bisphenol F novolak type epoxy resin, an alicyclic epoxy resin, an aliphatic chain-like epoxy resin, a glycidyl ester type epoxy resin, a hydantoin type epoxy resin, an isocyanurate type epoxy resin, a triphenol methane skeleton-containing phenol novolak type epoxy resin, and, in addition, a diglycidyl ether of bifunctional phenols, a diglycidyl ether of bifunctional alcohols, and a halogenated material thereof, a hydrogenated material thereof and the like. Among these, the epoxy resin is more preferably a bisphenol type epoxy resin or a novolak type epoxy resin from the viewpoint of liquid crystal contamination. In addition, the ratio of the epoxy group and the (meth)acryloyl group is not limited, and is suitably selected from the viewpoint of process suitability and liquid crystal contamination.

The content of the component (A) in the total amount of the liquid crystal sealant is preferably 40% to 90% by mass, and further preferably 50% to 85% by mass.

The liquid crystal sealant of the present invention contains the component (B) heat-curing agent. The heat-curing

agent is not particularly limited, and examples thereof include polyvalent amines, polyhydric phenols, hydrazide compound and the like, and particularly suitably polyvalent hydrazide compounds. Examples of the heat-curing agent may include aromatic hydrazides such as terephthalic acid dihydrazide, isophthalic acid dihydrazide, 2,6-naphthoic acid dihydrazide, 2,6-pyridine dihydrazide, 1,2,4-benzene trihydrazide, 1,4,5,8-naphthoic acid tetrahydrazide, pyromellitic acid tetrahydrazide. In addition, examples of the heat-curing agent may include aliphatic hydrazide compounds, such as formhydrazide, acetohydrazide, propionic acid hydrazide, oxalic acid dihydrazide, malonic acid dihydrazide, succinic acid dihydrazide, glutaric acid dihydrazide, adipic acid dihydrazide, pimelic acid dihydrazide, 1,4-cyclohexane dihydrazide, tartaric acid dihydrazide, malic acid dihydrazide, iminodiacetic acid dihydrazide, N,N'-hexamethylene bissemicarbazide, citric acid trihydrazide, nitriloacetic acid trihydrazide, cyclohexane tricarboxylic acid trihydrazide; dihydrazide compounds having a hydantoin skeleton, preferably a valine hydantoin skeleton (skeleton where a carbon atom of a hydantoin ring is substituted with an isopropyl group), such as 1,3-bis(hydrazinocarbonoethyl)-5-isopropyl hydantoin; tris(1-hydrazinocarbonylmethyl) isocyanurate, tris(2-hydrazinocarbonylethyl) isocyanurate, tris(2-hydrazinocarbonylethyl) isocyanurate, tris(3-hydrazinocarbonylpropyl) isocyanurate, and bis(2-hydrazinocarbonylethyl) isocyanurate. The heat-curing agent is

preferably isophthalic acid dihydrazide, malonic acid dihydrazide, adipic acid dihydrazide, tris(1-hydrazinocarbonylmethyl) isocyanurate, tris(2-hydrazinocarbonylethyl) isocyanurate, tris(2-hydrazinocarbonylethyl) isocyanurate, or tris(3-hydrazinocarbonylpropyl) isocyanurate, and particularly preferably malonic acid dihydrazide or tris(2-hydrazinocarbonylethyl) isocyanurate in terms of the balance between curing reactivity and potentiality. The content of such (B) heat-curing agent is preferably 0.5% to 5% by mass, and further preferably 1% to 3% by mass with respect to 100% by mass of the total amount of the liquid crystal sealant, and two or more kinds may be used in a mixture.

In the liquid crystal sealant of the present invention, the component (C) silane coupling agent may be used to seek improvement of adhesive strength and improvement of moisture proof reliability. Examples of the silane coupling agent include 3-glycidoxypropyl trimethoxysilane, 3-glycidoxypropyl methyldimethoxysilane, 3-glycidoxypropyl methyldimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyl trimethoxysilane, N-phenyl- γ -aminopropyl trimethoxysilane, N-(2-aminoethyl)-3-aminopropyl methyldimethoxysilane, N-(2-aminoethyl)-3-aminopropylmethyl trimethoxysilane, 3-aminopropyl triethoxysilane, 3-mercaptopropyl trimethoxysilane, vinyltrimethoxysilane, N-(2-(vinylbenzylamino)ethyl)-3-aminopropyl trimethoxysilane hydrochloride, 3-methacryloxypropyl trimethoxysilane, 3-chloropropyl methyldimethoxysilane, 3-chloropropyl

trimethoxysilane and the like. The content of the (C) silane coupling agent in the liquid crystal sealant is suitably 0.05% to 3% by mass with respect to 100% by mass of the total amount of the liquid crystal sealant of the present invention.

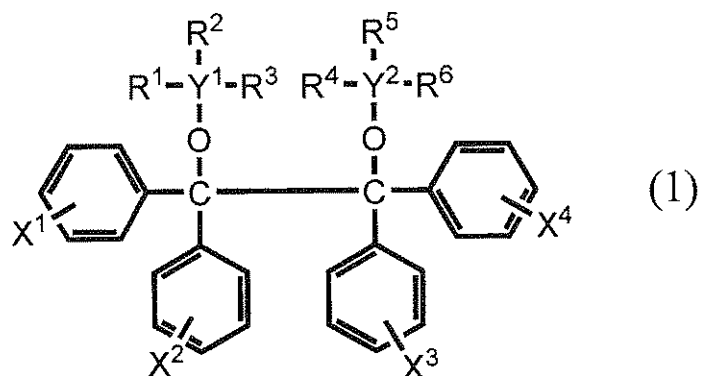
The component (D) inorganic filler may be used in the liquid crystal sealant of the present invention to seek improvement of adhesive strength and improvement of moisture proof reliability. Examples of this (D) inorganic filler include molten silica, crystalline silica, silicon carbide, silicon nitride, boron nitride, calcium carbonate, magnesium carbonate, barium sulfate, calcium sulfate, mica, talc, clay, alumina, magnesium oxide, zirconium oxide, aluminum hydroxide, magnesium hydroxide, calcium silicate, aluminum silicate, lithium aluminum silicate, zirconium silicate, barium titanate, glass fiber, carbon fiber, molybdenum bisulfide, asbestos and the like, preferably molten silica, crystalline silica, silicon nitride, boron nitride, calcium carbonate, barium sulfate, calcium sulfate, mica, talc, clay, alumina, aluminum hydroxide, calcium silicate and aluminum silicate, and further preferably molten silica, crystalline silica, alumina and talc. These inorganic fillers may be used in a mixture of two or more kinds. If the average particle diameter is too great, it becomes a defect factor such that a gap cannot be formed well when the upper and the lower glass substrates are laminated at the time of manufacture of a liquid crystal display cell having a narrow gap, and thus the average particle diameter is appropriately 3 μm or less, and preferably 2 μm or less. The

particle diameter can be measured by a laser diffraction/scattering type particle size distribution measurement apparatus (dry type) (manufactured by SEISHIN ENTERPRISE Co., Ltd.; LMS-30).

The content of the inorganic filler (D) in the liquid crystal sealant, which may be used in the liquid crystal sealant of the present invention, is typically 3% to 60% by mass, preferably 5% to 50% by mass with respect to 100% by mass of the total amount of the liquid crystal sealant of the present invention. If the content of the inorganic filler is too small, adhesive strength to a glass substrate decreases, and moisture proof reliability is also poor, and thus a decrease of adhesive strength after moisture absorption may increase. On the other hand, if the content of the inorganic filler is too great, it is hard to perform crushing and the gap of the liquid crystal cell cannot be formed.

In the liquid crystal sealant of the present invention, the component (E) thermal radical polymerization initiator may be used, whereby to improve the thermal reactivity. The thermal radical polymerization initiator is not particularly limited as long as it is a compound that generates radicals by heat, and initiates a chain polymerization reaction, and examples thereof include organic peroxide, an azo compound, a benzoin compound, a benzoin ether compound, an acetophenone compound, benzopinacol and the like, and suitably benzopinacol. For example, as the organic peroxide, commercial products are available such as Kayamek A, Kayamek M, Kayamek R, Kayamek L,

Kayamek LH, Kayamek SP-30C, Padokkusu CH-50L, Padokkusu BC-FF, Kadokkusu B-40ES, Padokkusu 14, Trigonox 22-70E, Trigonox 23-C70, Trigonox 121, Trigonox 121-50E, Trigonox 121-LS50E, Trigonox 21-LS50E, Trigonox 42, Trigonox 42LS, Kayaester P-70, Kayaester TMPO-70, Kayaester CND-C70, Kayaester O, Kayaester O-50E, Kayaester AN, Kayabutyl B, Padokkusu 16, Kayacarbon BIC-75, Kayacarbon AIC-75 (manufactured by Kayaku Akzo Corporation), Permek N, Permek H, Permek S, Permek F, Permek D, Permek G, Perhexa H, Perhexa HC, Perhexa TMH, Perhexa C, Perhexa V, Perhexa 22, Perhexa MC, Percure AH, Percure AL, Percure HB, Perbutyl H, Perbutyl C, Perbutyl ND, Perbutyl L, Percumyl H, Percumyl D, Peroyl IB, Peroyl IPP, Perocta ND, (manufactured by NOF CORPORATION). In addition, as the azo compound, commercial products are available such as VA-044, V-070, VPE-0201, VSP-1001 and the like (manufactured by Wako Pure Chemical Industries, Ltd.). In addition, the compound represented by formula (1) described below is, furthermore, particularly suitably used from the viewpoint of reactivity and solubility into liquid crystal.



In formula (1), Y^1 and Y^2 each independently represent a hydrogen atom, a phenyl group, or a silicon atom, R^1 to R^6 each

independently represent a hydrogen atom or a C1-C4 straight or branched alkyl group, and X^1 to X^4 each independently represent a hydrogen atom, a methyl group, an ethyl group, a methoxy group, an ethoxy group, a phenoxy group, or a halogen atom. However, R^1 to R^3 or R^4 to R^6 that are bonded respectively to Y^1 or Y^2 are not present when Y^1 or Y^2 is a hydrogen atom.

In formula (1), Y^1 and Y^2 each independently represent a hydrogen atom, a phenyl group, or a silicon atom, and preferably at least one of them is a silicon atom. In formula (1) of the present invention, examples of the C1-C4 straight or branched alkyl group (hereinafter, simply also referred to as the C1-C4 alkyl group) in R^1 to R^6 may include methyl, ethyl, n-propyl, i-propyl, t-butyl and the like. In addition, examples of the halogen in X^1 to X^4 may include a fluorine atom, a chlorine atom, a bromine atom and the like.

When Y^1 or Y^2 of formula (1) is not a hydrogen atom, $R^1R^2R^3Y^1-$ or $R^4R^5R^6Y^2-$ is preferably a phenyl group, a phenyl group substituted with one to three C1-C4 alkyl groups, a di(C1-C4 alkyl)silyl group, or a tri(C1-C4 alkyl)silyl group, and more preferably a di(C1-C4 alkyl)silyl group or a tri(C1-C4 alkyl)silyl group, and even more preferably a tri(C1-C4 alkyl)silyl group.

The two or three C1-C4 alkyl groups in the di- or tri-(C1-C4 straight or branched alkyl)silyl group in $R^1R^2R^3Y^1-$ or $R^4R^5R^6Y^2-$ of formula (1) may be the same or different. Examples of the silyl group include di(C1-C4 alkyl)silyl groups, such as dimethylsilyl, diethylsilyl and methylethylsilyl; and

tri(C1-C4 alkyl)silyl groups such as trimethylsilyl, triethylsilyl, dimethylethylsilyl and t-butyldimethylsilyl. Among them, the silyl group is most preferably a tri(C1-C4 alkyl)silyl group, and more preferably a trimethylsilyl group.

X^1 to X^4 of formula (1) each independently represent a hydrogen atom, a methyl group, an ethyl group, a methoxy group, an ethoxy group, a phenoxy group, or a halogen atom, and preferably all of X^1 to X^4 are a hydrogen atom.

Examples of the compound represented by formula (1) include, specifically, benzopinacol, 1,2-dimethoxy-1,1,2,2-tetraphenylethane, 1,2-diethoxy-1,1,2,2-tetraphenylethane, 1,2-diphenoxy-1,1,2,2-tetraphenylethane, 1,2-dimethoxy-1,1,2,2-tetra(4-methyl phenyl)ethane, 1,2-diphenoxy-1,1,2,2-tetra(4-methoxyphenyl)ethane, 1,2-bis(trimethylsiloxy)-1,1,2,2-tetraphenylethane, 1,2-bis(triethylsiloxy)-1,1,2,2-tetraphenylethane, 1,2-bis(t-butyldimethylsiloxy)-1,1,2,2-tetraphenylethane, 1-hydroxy-2-trimethylsiloxy-1,1,2,2-tetraphenylethane, 1-hydroxy-2-triethylsiloxy-1,1,2,2-tetraphenylethane, 1-hydroxy-2-t-butyldimethylsiloxy-1,1,2,2-tetraphenylethane and the like, preferably 1-hydroxy-2-trimethylsiloxy-1,1,2,2-tetraphenylethane, 1-hydroxy-2-triethylsiloxy-1,1,2,2-tetraphenylethane, 1-hydroxy-2-t-butyldimethylsiloxy-1,1,2,2-tetraphenylethane and 1,2-bis(trimethylsiloxy)-1,1,2,2-tetraphenylethane, and, even more preferably 1-hydroxy-2-trimethylsiloxy-1,1,2,2-tetraphenylethane and 1,2-bis(trimethylsiloxy)-1,1,2,2-tetraphenylethane. However, the compound represented by

formula (1) is not limited to these compounds as long as the compound has the structure of formula (1). In addition, two or more kinds may be used in combination.

Among the thermal radical polymerization initiators, benzopinacol is marketed from Tokyo Chemical Industry Co., Ltd., Wako Pure Chemical Industries, Ltd. and the like. A compound obtained by silyl etherification of the hydroxy group of benzopinacol can be synthesized by a method of heating a corresponding benzopinacol and various silylating agents under a basic catalyst, such as pyridine.

Examples of the silylating agent include generally known trimethylsilylating agents, such as trimethyl chlorosilane (TMCS), hexamethyl disilazane (HMDS) and N,O-bis(trimethylsilyl)trifluoroacetoamide (BSTFA), triethylsilylating agents, such as triethyl chlorosilane (TECS), t-butyldimethylsilylating agents, such as t-butylmethyl silane (TBMS). These reagents are easily available from the market, such as makers of silicon derivatives. The reaction amount of the silylating agent is preferably 1.0 to 5.0-fold moles with respect to 1 mole of the hydroxy group of the subject compound. The reaction amount is even more preferably 1.5 to 3.0-fold moles. If the reaction amount is less than 1.0-fold mole, reaction efficiency is poor, and the reaction time becomes long, and thus heat decomposition is promoted. If the reaction amount is 5.0-fold moles, isolation becomes worse in the recovery, and purification becomes difficult.

Examples of the basic catalyst include pyridine, triethyl amine and the like. The basic catalyst has effects of trapping hydrogen chloride generated at the time of the reaction, and keeping the reaction system basic, and the effects of pulling out hydrogen from a hydroxy group, and promoting the reaction further. The content of the basic catalyst may be 0.5-fold moles or more with respect to a hydroxy group of the subject, and the basic catalyst may be used as a solvent.

As the solvent, a non-polar organic solvent such as hexane, ether or toluene is excellent since it does not participate in the reaction. In addition, the solvent is also preferably a polar solvent such as pyridine, dimethyl formaldehyde (DMF), dimethyl sulfoxide (DMSO), tetrahydrofuran (THF) or acetonitrile. The content of the solvent is preferably such an amount that the mass concentration of the solute is 5% to 40% by mass. The content of the solvent is further preferably 10% to 30% by mass. If the content of the solvent is less than 5%, the reaction is slow, decomposition by heat is promoted and the yield decreases. If the content of the solvent is over 40%, byproducts increase, and the yield decreases.

The component (E) thermal radical polymerization initiator is preferably those making the particle diameter fine, and being uniformly dispersed. If the average particle diameter is too great, it becomes a defect factor in such that a gap cannot be formed well when the upper and the lower glass substrates are laminated at the time of manufacture of the

liquid crystal display cell having a narrow gap, and thus is preferably 5 μm or less and more preferably 3 μm or less. In addition, the average particle diameter may be fine without limit, but ordinarily the lower limit is about 0.1 μm . The particle diameter can be measured by a laser diffraction and scattering type particle size distribution measurement apparatus (dry type) (manufactured by SEISHIN ENTERPRISE Co., Ltd.; LMS-30).

The content of the thermal radical polymerization initiator is preferably 0.0001% to 10% by mass, more preferably 0.0005% to 7% by mass, and particularly preferably 0.001% to 3% by mass with respect to 100% by mass of the total amount of the liquid crystal sealant of the present invention.

The liquid crystal sealant of the present invention may contain the component (F) photo-radical polymerization initiator in order to render the liquid crystal sealant to be a light-heat combination curing type liquid crystal sealant. The photopolymerization initiator is not particularly limited as long as it is a compound that generates radicals by irradiation of UV or visible light, and initiates a chain polymerization reaction, and examples thereof may include benzyldimethyl ketal, 1-hydroxycyclohexylphenylketone, diethylthioxanthone, benzophenone, 2-ethyl anthraquinone, 2-hydroxy-2-methyl propiophenone, 2-methyl-[4-(methylthio)phenyl]-2-morpholino-1-propane, 2,4,6-trimethyl benzoyldiphenyl phosphine oxide and the like. In addition, those having a (meth)acryloyl group in the molecule are

preferably used, and for example, a reaction product of 2-methacryloyloxyethyl isocyanate and 1-[4-(2-hydroxy ethoxy)-phenyl]-2-hydroxy-2methyl-1-propan-1-one is suitably used from the viewpoint of the contamination of the liquid crystal. This compound may be obtained by the manufacture according to the method described in WO 2006/027982.

The content of the component (F) photopolymerization initiator in the liquid crystal sealant, which may be used in the liquid crystal sealant of the present invention, is ordinarily 0.5% to 20% by mass, and preferably 1% to 15% by mass with respect to 100% by mass of the total amount of the liquid crystal sealant of the present invention.

In the liquid crystal sealant of the present invention, a monomer or an oligomer of (meth)acrylic acid ester may be also used as necessary. Examples of such monomer or oligomer include a reaction product of dipentaerythritol and (meth)acrylic acid, a reaction product of dipentaerythritol caprolactone and (meth)acrylic acid and the like, but are not particularly limited as long as the monomer or oligomer has little contamination with respect to the liquid crystal.

The liquid crystal sealant of the present invention may be also blended with a curing accelerator, such as an organic acid and an imidazole, an organic filler, and an additive, such as a pigment, a leveling agent, an antifoam agent and a solvent as necessary.

A method is described below as one example of a method for obtaining the liquid crystal sealant of the present

invention. First, the other curable resins are mixed in the component (a) as necessary to prepare the component (A), and, furthermore, the component (F) is heat-dissolved as necessary. Then, the solution is cooled to room temperature, and then combined with the component (B), and also combined with the component (C), the component (D), the component (E), and an organic filler, an antifoam agent, a leveling agent, a solvent and the like as necessary, uniformly mixed with a known mixing apparatus, for example, a three-roller milling machine, a sand mill, a ball mill or the like, and filtered with a metal mesh, whereby to manufacture the liquid crystal sealant of the present invention.

The liquid crystal display cell of the present invention is obtained by disposing one pair of substrates on which prescribed electrodes are formed in opposition to the substrate at a prescribed interval, sealing the circumference with the liquid crystal sealant of the present invention, and enclosing a liquid crystal into the space. The kind of the enclosed liquid crystal is not particularly limited. Herein, the substrates are formed of a combination of substrates such as glass, quartz, plastic, and silicon, in which at least one of the substrates is light-transmissive. As the manufacturing method thereof, the liquid crystal sealant of the present invention is combined with a spacer such as a glass fiber (space control material), and then the liquid crystal sealant is applied onto one of the pair of substrates using a dispenser, or a screen print apparatus or the like, and then

temporary curing is performed at 80 to 120°C as necessary. Then, liquid crystal is dropped into the inside of the weir of the liquid crystal sealant, and the other glass substrate is superposed in a vacuum to perform gap formation. After the gap formation, curing is performed at 90 to 130°C for 1 to 2 hours to obtain the liquid crystal display cell of the present invention. In addition, when a light-heat combination type is used, the portion of the liquid crystal sealant is irradiated with ultraviolet light using an ultraviolet light irradiation machine to perform the photocuring. The irradiation amount of ultraviolet light is preferably 500 to 6000 mJ/cm², and more preferably 1000 to 4000 mJ/cm². Then, as necessary, curing is performed at 90 to 130°C for 1 to 2 hours to obtain the liquid crystal display cell of the present invention. The liquid crystal display cell thus obtained of the present invention does not have display defects due to contamination of the liquid crystal, and is excellent in the adhesiveness and the moisture proof reliability. Examples of the spacer include glass fibers, silica beads, polymer beads and the like. The diameter thereof varies depending on the purpose, but typically 2 to 8 μm, and preferably 4 to 7 μm. The amount used is typically 0.1% to 4% by mass, preferably 0.5% to 2% by mass, and even more preferably 0.9% to 1.5% by mass with respect to 100% by mass of the liquid crystal sealant of the present invention.

The liquid crystal sealant of the present invention has good reactivity, and is promptly crosslinked between the

molecules by light or by heat, and thus elution of the constituting components into the liquid crystal is extremely low, and display defects of the liquid crystal display cell can be reduced. In addition, the liquid crystal sealant of the present invention is also excellent in terms of the storage stability, and thus is suitable for manufacture of the liquid crystal display cell. Furthermore, a cured product thereof is also excellent in various cured product properties such as adhesive strength, heat resistance and humidity resistance, and thus by using the liquid crystal sealant of the present invention, it is possible to prepare a liquid crystal display cell having excellent reliability. In addition, a liquid crystal display cell prepared using the liquid crystal sealant of the present invention has a high voltage-holding rate, and low ion density, and thus meets the properties necessary for a liquid crystal display cell.

EXAMPLES

Hereinafter, the present invention is further specifically described with Synthesis Examples and Examples, but the present invention is not limited to the Examples. Meanwhile, "part" and "%" in the text are on a mass basis unless otherwise stated.

Synthesis Example 1: Synthesis of reaction product of glycidyl methacrylate and acrylic acid (compound No. 1 in Table 1)

298.2 g of glycidyl methacrylate (product name: Brenmar

GH, manufactured by NOF CORPORATION) and 0.9 g of dibutyl hydroxytoluene as a polymerization inhibitor were dissolved in 450 g of toluene, and the reaction liquid was heated to 60°C. Then, 151.2 g of acrylic acid as 100% equivalent to the epoxy group were added, and the reaction liquid was heated further to 80°C, and combined with 0.85 g of trimethyl ammonium chloride as a reaction catalyst, and stirred at 98°C for about 30 hours to obtain the reaction liquid. This reaction liquid was washed with water, and the toluene was distilled off, whereby to obtain 438 g of the intended reaction product of glycidyl methacrylate and acrylic acid.

Synthesis Example 2: Synthesis of reaction product of the reaction product of glycidyl methacrylate and acrylic acid with isocyanate compound (mixture of compound Nos. 8 and 9 in Table 3)

200 g of the reaction product of glycidyl methacrylate and acrylic acid obtained in Synthesis Example 1 and 0.13 g of dibutyl hydroxytoluene as a polymerization inhibitor were combined and mixed. Then, 64.5 g of tolylene diisocyanate (product name: CORONATE T-100, manufactured by NIPPON POLYURETHANE INDUSTRIES CO., LTD.) were slowly added with attention to generation of heat, and the mixture was stirred at 80°C for 7 hours to obtain the reaction liquid. This reaction liquid was washed with water to obtain 186 g of the intended reaction product of a reaction product of glycidyl methacrylate and acrylic acid and the isocyanate compound.

Reference Synthesis Example 1: Synthesis of epoxy acrylate of bisphenol A type epoxy resin

282.5 g of a bisphenol A type epoxy resin (product name: YD-8125, manufactured by NIPPON STEEL & SUMIKIN CHEMICAL CO., LTD.) were dissolved in 266.8 g of toluene, and 0.8 g of dibutyl hydroxytoluene as a polymerization inhibitor were added thereto, and the reaction liquid was heated to 60°C. Then, 117.5 g of acrylic acid as 100% equivalent to the epoxy group were added, and the reaction liquid was heated further to 80°C, combined with 0.6 g of trimethyl ammonium chloride as a reaction catalyst, and stirred at 98°C for about 30 hours to obtain the reaction liquid. This reaction liquid was washed with water, and toluene was distilled off, whereby to obtain 395 g of the intended bisphenol A type epoxy acrylate (KAYARAD^{RTM} R-93100).

Reference Synthesis Example 2: Synthesis of epoxy methacrylate of bisphenol A type epoxy resin

282.5 g of a bisphenol A type epoxy resin (product name: YD-8125, manufactured by NIPPON STEEL & SUMIKIN CHEMICAL CO., LTD.) were dissolved in 266.8 g of toluene, 0.8 g of dibutyl hydroxytoluene as a polymerization inhibitor were added thereto, and the reaction liquid was heated to 60°C. Then, 140.4 g of methacrylic acid as 100% equivalent to the epoxy group were added, and the reaction liquid was heated further to 80°C, combined with 0.6 g of trimethyl ammonium chloride as

a reaction catalyst, and stirred at 98°C for about 30 hours to obtain the reaction liquid. This reaction liquid was washed with water, and toluene was distilled off, whereby to obtain 395 g of the intended bisphenol A type epoxy acrylate (KAYARAD^{RTM} RM-93100).

Reference Synthesis Example 3: Synthesis of 1-hydroxy-2-trimethylsiloxy-1,1,2,2-tetraphenylethane

100 Parts (0.28 mol) of marketed benzopinacol (manufactured by Tokyo Chemical Industry Co., Ltd.) were dissolved in 350 parts of dimethyl formaldehyde. 32 Parts (0.4 mol) of pyridine as a basic catalyst, and 150 parts (0.58 mol) of BSTFA (manufactured by Shin-Etsu Chemical Co., Ltd.) as a silylating agent were added thereto, and the reaction liquid was heated to 70°C, and stirred for 2 hours. The obtained reaction liquid was cooled, and combined with 200 parts of water while being stirred, and the product was precipitated and the unreacted silylating agent was deactivated. The precipitated product was filtered and isolated, and then sufficiently washed with water. Then, the obtained product was dissolved in acetone, and combined with water and recrystallized, and purified. 105.6 Parts (yield 88.3%) of the intended 1-hydroxy-2-trimethylsiloxy-1,1,2,2-tetraphenylethane were obtained. The purity analyzed with HPLC (high performance liquid chromatography) was 99.0% (area percentage).

(Preparation of liquid crystal sealant for use in the liquid

crystal one-drop fill process)

Examples 1-3 and Comparative Examples 1-3

Each of the curable resin components (the component (a) and the other curable resins) was mixed in the ratio shown in Table 4 described below and stirred, and then heated to 90°C. Then, the photo-radical polymerization initiator (component (F)) was heat-dissolved, and then the solution was cooled to room temperature, combined with the silane coupling agent (component (C)), the inorganic filler (component (D)), the heat-curing agent (component (B)) and thermal radical polymerization initiator (component (E)), and stirred, and then dispersed with a three-roller milling machine, and filtered with a metal mesh (635 mesh), to prepare the liquid crystal sealants for the liquid crystal one-drop fill process of Examples 1 to 3. In addition, the liquid crystal sealants for use in the liquid crystal one-drop fill process of Comparative Examples 1 to 3 were prepared likewise in the ratio shown in Table 4 described below.

(Test for storage stability)

The viscosity change of the obtained liquid crystal sealant at 25°C was measured. The viscosity measurement was performed after the obtained liquid crystal sealant was kept under the conditions of 25°C and 50 RH% for 120 hours, and the viscosity increase rate (%) with respect to the initial viscosity was calculated. The results are shown in Table 4. The viscosity was measured using E type viscometer

(manufactured by TOKI SANGYO CO., LTD).

(Preparation of liquid crystal cell for evaluation)

An alignment film liquid (PIA-5540-05A; manufactured by CHISSO CORPORATION) was applied onto a transparent substrate having electrodes, and burned, and subjected to rubbing treatment. The liquid crystal sealant was dispensed onto this substrate such that the line width after the bonding was 1 mm whereby to perform main sealing and dummy sealing, and then, microdroplets of the liquid crystal (JC-5015LA; manufactured by CHISSO CORPORATION) were dropped in a frame of the seal pattern. Furthermore, onto a substrate already finished with the rubbing treatment for one piece, in-plane spacers (Natoco spacer KSEB-525F; manufactured by Natoco Co., Ltd.; 5 μm gap width after the lamination) were sprayed, heat-fixed, and laminated to the substrate previously finished with the liquid crystal dropping using a lamination apparatus in vacuo. The atmosphere was opened and a gap was formed, and then the substrate was irradiated with 3000 mJ/cm^2 ultraviolet light with a UV irradiation machine while only the inside of the seal pattern frame was masked, and then placed into an oven and heat-cured at 120°C for 1 hour, whereby to prepare the liquid crystal test cell for evaluation.

The plug-in resistance of the seal and the turbulence in alignment of the liquid crystal in the vicinity of the seal of the prepared liquid crystal cell for evaluation were observed with a polarizing microscope, and the plug-in resistance and

the alignment of the liquid crystal in the vicinity of the seal were evaluated in accordance with the criteria shown below. The results are shown in Table 4.

(Evaluation for liquid crystal alignment in the vicinity of the seal)

S: The turbulence of the liquid crystal alignment from the seal is less than 0.2 mm.

A: The turbulence of the liquid crystal alignment from the seal is 0.2 mm or more and less than 0.4 mm.

B: The turbulence of the liquid crystal alignment from the seal is 0.4 mm or more and less than 0.6 mm.

C: The turbulence of the liquid crystal alignment from the seal is 0.6 mm or more and less than 1.0 mm.

F: The seal is collapsed, and the cell cannot be formed.

(Test for curing speed)

With respect to the obtained liquid crystal sealant, complex viscosity was measured with an apparatus for measuring the dynamic viscoelasticity (Rheosol-G5000, manufactured by UBM). The settings of the apparatus for measuring the dynamic viscoelasticity are as described below. Cone: parallel cone having 20 mm diameter, frequency: 1 Hz, deformation angle: 3 deg., the measurement temperature was elevated at a speed of 18°C/minute from 30°C, to 120°C, and then maintained at 120°C. The time to 10000 Pa.s of the viscosity is shown in Table 4.

(Test for adhesive strength)

To 1 g of the obtained liquid crystal sealant, 0.01 g of 5 μm glass fiber as a spacer was added and the mixture was mixed and stirred. This liquid crystal sealant was applied to a 50 mm $\times$ 50 mm glass substrate, and 1.5 mm $\times$ 1.5 mm glass fragments were laminated onto the liquid crystal sealant, and photocured by 3000 mJ/cm² UV irradiation, and then placed in a 120°C oven for 1 hour and heat-cured further. The shear adhesive strength of the glass fragment was measured using a bond tester (SS-30WD: manufactured by SEISHIN TRADING CO., LTD). The results are shown in Table 4.

[Table 4]

			Example 1	Example 2	Example 3
Component (A)	#1	Reaction product of acrylic acid with glycidyl methacrylate	6 parts	5 parts	16 parts
Component (a)	#2	Reaction product of reaction product of glycidyl methacrylate and acrylic acid with isocyanate compound	10 parts	8 parts	
Component (A)	#3	KAYARAD R-93100		3 parts	
Other curable resins	#4	KAYARAD RM-93100			
	#5	Resorcin diglycidyl ether	1.5 parts	1.5 parts	1.5 parts
Component (B)	#6	Malonic acid dihydrazide	0.49 parts	0.49 parts	0.49 parts
Component (C)	#7	3-Glycidioxypropyl trimethoxysilane	0.05 parts	0.05 parts	0.05 parts
Component (D)	#8	Talc	3 parts	3 parts	3 parts
Component (E)	#9	1-Hydroxy-2-trimethylsiloxy-1,1,2,2-tetra phenylethane	0.01 parts	0.01 parts	0.01 parts
Component (F)	#10	Reaction product of 2-methacryloyloxyethyl isocyanate and 1-[4-(2-hydroxy ethoxy)-phenyl]-2-hydroxy-2methyl-1-propa n-1-one	1 part	1 part	1 part
Initial viscosity at 25°C and 5 rpm (Pa·s)			380	360	80
Storage stability test (%)			10.9	20.2	8.5
Evaluation for liquid crystal alignment in vicinity of seal			A	A	A
Curing speed (seconds)			20	18	20
Adhesive strength (MPa)			68	65	59

			Compara tive Example 1	Compara tive Example 2	Compara tive Example 3
Component (A)	#1	Reaction product of acrylic acid with glycidyl methacrylate			
Component (a)	#2	Reaction product of reaction product of glycidyl methacrylate and acrylic acid with isocyanate compound			
Component (A)	#3	KAYARAD R-93100	16 parts		8 parts
Other curable resins	#4	KAYARAD RM-93100		16 parts	8 parts
	#5	Resorcin diglycidyl ether	1.5 parts	1.5 parts	1.5 parts
Component (B)	#6	Malonic acid dihydrazide	0.49 parts	0.49 parts	0.49 parts
Component (C)	#7	3-Glycidoxypropyl trimethoxysilane	0.05 parts	0.05 parts	0.05 parts
Component (D)	#8	Talc	3 parts	3 parts	3 parts
Component (E)	#9	1-Hydroxy-2-trimethylsiloxy-1,1,2,2-tetra phenylethane	0.01 parts	0.01 parts	0.01 parts
Component (F)	#10	Reaction product of 2-methacryloyloxyethyl isocyanate and 1-[4-(2-hydroxy ethoxy)-phenyl]-2-hydroxy-2methyl-1-propa n-1-one	1 part	1 part	1 part
Initial viscosity at 25°C and 5 rpm (Pa·s)			320	340	330
Storage stability test (%)			32.1	5.3	14.9
Evaluation for liquid crystal alignment in vicinity of seal			A	C	C
Curing speed (seconds)			9	600 or more	600 or more
Adhesive strength (MPa)			60	56	58

#1 : Synthesized from Synthesis Example 1

#2 : Synthesized from Synthesis Example 2

#3 : Synthesized from Reference Synthesis Example 1

#4 : Synthesized from Reference Synthesis Example 2

#5 : 1,3-Bis(oxiranylmethoxy)benzene (marketed by Nagase Chemtex Corporation)

#6 : MDH (Manufactured by Otsuka Chemical Co., Ltd.)

#7 : Sila-Ace S-510 (manufactured by CHISSO CORPORATION)

#8 : D-600 (Manufactured by Nippon Talc Co., Ltd.)

#9 : Synthesized from Reference Synthesis Example 3

#10 : Synthesized with the method described in WO 2006/027982 A

From the results of Table 4, Comparative Example 1 constituted with epoxy acrylate only as the (meth)acrylic component among the curable resins, showed very poor storage stability results. In addition, Comparative Example 2 constituted with epoxy methacrylate only as the (meth)acrylic component among the curable resins has a slow reaction, and thus the resin is eluted into the liquid crystal, and a defect of the liquid crystal alignment is caused although Comparative Example 2 has good storage stability. In addition, Comparative Example 3 in which epoxy acrylate and epoxy methacrylate are mixed as the (meth)acrylic component among the curable resins, has poor results in terms of both storage stability and the defects of the liquid crystal alignment due to respective disadvantages of each component. On the contrary to this, it is understood that the liquid crystal sealants of Examples 1 to 3 are liquid crystal sealants having a balance between storage stability and low liquid crystal contamination. Furthermore, the liquid crystal sealants of Examples 1 and 2 are also very excellent in terms of the adhesive strength of the cured material.

From this, it can be said that the liquid crystal sealant of the present invention is excellent in terms of workability,

and a liquid crystal display cell manufactured using this also has excellent reliability.

INDUSTRIAL APPLICABILITY

The liquid crystal sealant of the present invention has extremely little influence on the display properties of the liquid crystal, and thus allows increased resolution, fast response, lower voltage driving and longer service life of liquid crystal display elements, and, furthermore, is excellent in terms of storage stability, and thus contributes to easy manufacture of a liquid crystal display cell. In addition, the liquid crystal sealant of the present invention has excellent cured material properties, such as adhesive strength, and thus manufacture of liquid crystal display elements having high reliability can be realized.

CLAIMS

1. A liquid crystal sealant for use in a liquid crystal one-drop fill process, comprising (A) a curable resin and (B) a heat-curing agent, wherein the component (A) contains (a) a compound having one or more each of an acryloyl group and a methacryloyl group in each molecule thereof.

2. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to claim 1, wherein the component (a) is a compound that also has a hydrogen bond functional group in the molecule.

3. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to claim 2, wherein the hydrogen bond functional group is a hydroxy group or an amide group.

4. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 3, wherein the component (a) is either one or both of (a-1) a reaction product of glycidyl methacrylate and acrylic acid and (a-2) a reaction product of the (a-1) and an isocyanate compound.

5. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to claim 4, wherein the

isocyanate compound is a diisocyanate compound.

6. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to claim 4 or 5, wherein the isocyanate compound is tolylene diisocyanate.

7. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to claim 4, wherein the component (a) is a mixture of the component (a-1) and the component (a-2).

8. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 7, wherein the component (A) contains the component (a) in 60% by mass or more.

9. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 8, wherein the content of the component (A) in the total mass of the liquid crystal sealant is 40% to 90% by mass.

10. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 9, further comprising (C) a silane coupling agent.

11. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 10,

further comprising (D) an inorganic filler.

12. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 11, further comprising (E) a thermal radical polymerization initiator.

13. The liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 12, further comprising (F) a photo-radical polymerization initiator.

14. A liquid crystal display cell sealed with a cured product obtained by curing the liquid crystal sealant for use in the liquid crystal one-drop fill process according to any one of claims 1 to 13.