

DESCRIPTION

TITLE OF INVENTION: POLYVINYL ACETAL RESIN, AND RESIN
COMPOSITION FOR CERAMIC GREEN SHEET

5

TECHNICAL FIELD

[0001]

The present invention relates to polyvinyl acetal
resins and resin compositions for a ceramic green sheet.

10

BACKGROUND ART

[0002]

In recent years, electronic components installed in
various electronic devices have become increasingly smaller
and multilayered. Multilayer electronic components, such
as multilayer circuit boards, multilayer coils, and
multilayer ceramic capacitors, have been widely used.

Multilayer ceramic capacitors are typically produced
through the following steps.

First, a plasticizer, a dispersant, and the like are
added to a solution of a binder resin such as a polyvinyl
butyral resin or a poly(meth)acrylate resin in an organic
solvent. Ceramic raw material powder is then added and
uniformly mixed in a mixer such as a bead mill or a ball
mill and deaerated, whereby a ceramic slurry composition
having a specific viscosity is obtained. This slurry
composition is cast on a surface of a support such as a
release-treated polyethylene terephthalate film or a SUS
plate using a doctor blade, a reverse roll coater, or the
like. The slurry composition is subjected to heating or
the like to remove the solvent and other volatile
components, and then separated from the support to give a
ceramic green sheet.

Next, the obtained ceramic green sheet is screen-
printed with a conductive paste that is to serve as an

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internal electrode. Sheets obtained in this manner are stacked such that the ceramic green sheets and the conductive paste layers alternate with each other, and thermally pressure-bonded to produce a laminate. The
5 obtained laminate is subjected to a treatment called debinding, that is, a treatment to remove components such as the binder resin component in the laminate by heat decomposition. The laminate is then fired to produce a ceramic sintered body, and external electrodes are sintered
10 to the end surfaces of the ceramic sintered body. Through these steps, a multilayer ceramic capacitor is obtained.
[0003]

Resin compositions for a ceramic green sheet used for producing ceramic green sheets are typically used as
15 solutions containing polyvinyl acetal resins dissolved in organic solvents such as methyl ethyl ketone, toluene, alcohols, and mixtures of these. However, conventional polyvinyl acetal resins may leave trace amounts of undissolved matter when dissolved in organic solvents.
20 Such undissolved matter present in solutions used in multilayer ceramic capacitors tends to cause voids in the debinding step and the firing step or lowers the dispersibility of ceramic powder and the like, thus lowering the electrical properties of the resulting
25 products.

Thus, using polyvinyl acetal resins in ceramic green sheet applications requires removal of undissolved matter by a filtration step after blending the polyvinyl acetal resin with organic/inorganic compounds and the like and
30 dissolving them in an organic solvent.
[0004]

In response to this, Patent Literature 1 proposes a polyvinyl acetal resin, wherein the rate of decrease in filtration flow rate is lower than 10% when a 5% by weight
35 solution of the polyvinyl acetal resin in a 1:1 solvent

mixture of methyl ethyl ketone and/or toluene and ethanol is filtrated using a 5- μ m-aperture filter at a filtration temperature of 25°C and a filtration pressure of 10 mmHg. Patent Literature 1 teaches that using such a polyvinyl
5 acetal resin can improve productivity because such a resin leaves less undissolved matter when dissolved in an organic solvent and thus can shorten the filtration time.

CITATION LIST

- 10 - Patent Literature
[0005]
Patent Literature 1: JP 2005-325342 A

SUMMARY OF INVENTION

- 15 - Technical problem
[0006]

Meanwhile, with the recent increase in functionality and reduction in size of electronic devices, multilayer ceramic capacitors having larger capacity and smaller size
20 have been demanded, and further thinning of ceramic green sheets has been demanded.

However, use of the polyvinyl acetal resin described in Patent Literature 1 provides a ceramic green sheet with insufficient strength.

- 25 Furthermore, during laminating and drying ceramic green sheets, delamination (separation between layers) and dimensional changes may occur. When delamination and dimensional changes occur with the thinning of ceramic green sheets, defects in the appearance of the laminate
30 occur after cutting the laminate.

[0007]

- The present invention aims to provide a polyvinyl acetal resin and a resin composition for a ceramic green sheet. The polyvinyl acetal resin and the resin
35 composition can provide a ceramic green sheet in which

ceramic powder has excellent dispersibility and excellent dispersion stability and which has high strength and is less susceptible to delamination and dimensional changes during drying. The polyvinyl acetal resin and the resin composition can also provide a multilayer ceramic capacitor with excellent reliability.

- Solution to problem
[0008]

10 The disclosure (1) relates to a polyvinyl acetal resin having a Z average molecular weight (M_z) of 700,000 or more and 2,500,000 or less and a molecular weight differential distribution value at $\text{Log } M = 6.00$ of 5.00 or more and 110.0 or less.

15 The disclosure (2) relates to the polyvinyl acetal resin according to the disclosure (1), wherein a hydroxy group content relative to the Z average molecular weight ($\text{Hydroxy group content}/Z \text{ average molecular weight}$) is 1.30×10^{-5} or more.

20 The disclosure (3) relates to the polyvinyl acetal resin according to the disclosure (1) or (2), wherein the acetal group content is 50 to 83 mol%.

 The disclosure (4) relates to a resin composition for a ceramic green sheet, the resin composition containing the polyvinyl acetal resin according to any of the disclosures (1) to (3) and a plasticizer.

25 The present invention is described in detail below.
[0009]

 As a result of intensive studies, the present
30 inventors found out that a polyvinyl acetal resin having a Z average molecular weight and a molecular weight differential distribution value at $\text{Log } M = 6.00$ within predetermined ranges can provide a ceramic green sheet in which ceramic powder has excellent dispersibility and
35 excellent dispersion stability and which has high strength

and is less susceptible to delamination and dimensional changes during drying. Such a polyvinyl acetal resin can also provide a multilayer ceramic capacitor with excellent reliability. The inventors thus completed the present invention.

[0010]

The polyvinyl acetal resin of the present invention has a Z average molecular weight (M_z) of 700,000 or more and 2,500,000 or less and a molecular weight differential distribution value at $\text{Log } M = 6.00$ of 5.00 or more and 110.0 or less.

The polyvinyl acetal resin can provide a ceramic green sheet which has high strength and is less susceptible to delamination and dimensional changes during drying.

[0011]

The polyvinyl acetal resin of the present invention has a Z average molecular weight (M_z) of 700,000 or more and 2,500,000 or less. When the M_z falls within the above range, the wettability of the polyvinyl acetal resin with the ceramic powder is improved, resulting in enhanced dispersion stability.

The M_z is preferably 750,000 or more, more preferably 800,000 or more, and is preferably 2,400,000 or less, more preferably 2,300,000 or less, still more preferably 1,490,000 or less. In other words, the Z average molecular weight is 700,000 to 2,500,000, preferably 750,000 to 2,400,000, more preferably 750,000 to 2,300,000, still more preferably 800,000 to 1,490,000.

The M_z can be measured using N-methylpyrrolidone as a solvent by gel permeation chromatography (GPC) using appropriate standards (e.g., polystyrene standards).

[0012]

The polyvinyl acetal resin of the present invention has a molecular weight differential distribution value at $\text{Log } M = 6.00$ of 5.00 or more and 110.0 or less. When the

molecular weight differential distribution value is within the above range, the dispersibility and the strength can be both achieved in a balanced manner.

The molecular weight differential distribution value at Log M = 6.00 is preferably 7.00 or more, more preferably 8.00 or more, and is preferably 100.0 or less, more preferably 95.0 or less. In other words, the molecular weight differential distribution value at Log M = 6.00 is 5.00 to 110.0, preferably 7.00 to 100.0, more preferably 8.00 to 95.0.
[0013]

In the present invention, the "molecular weight differential distribution value at Log M = 6.00" refers to a differential distribution value when log M, which is the logarithm of the molecular weight M, is 6.00. The value does not simply indicate that the average molecular weight is high, but rather reflects the proportion of high molecular weight components in the resin.

FIG. 1 shows, as an example of the molecular weight differential distribution value, a molecular weight differential distribution curve with Log M on the horizontal axis and the molecular weight differential distribution value on the vertical axis. The molecular weight differential distribution value is not a detected value by optical measurement, but a "value obtained by differentiating the concentration fraction by the logarithm of the molecular weight". The present invention defines that the molecular weight differential distribution value at Log M of 6.00 is 5.00 or more and 110.0 or less.

The molecular weight differential distribution value at Log M = 6.00 can be determined by subjecting a sample prepared by dissolving the measurement target polyvinyl acetal resin in tetrahydrofuran (THF) at a concentration of 0.2% by weight to measurement by gel permeation chromatography (GPC).

[0014]

The molecular weight differential distribution value at the above-described Mz and Log M = 6.00 can be adjusted, for example, by changing the average degree of
5 polymerization and the degree of saponification of the raw material polyvinyl alcohol resin, and the temperature and time conditions of the acetalization reaction, and by appropriately setting the acetal group content, the hydroxy group content, and the acetyl group content of the
10 polyvinyl acetal resin.

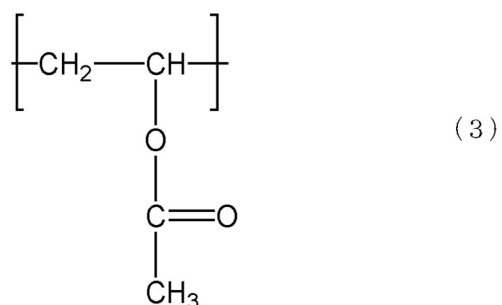
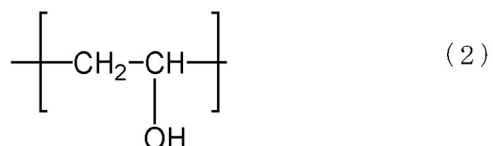
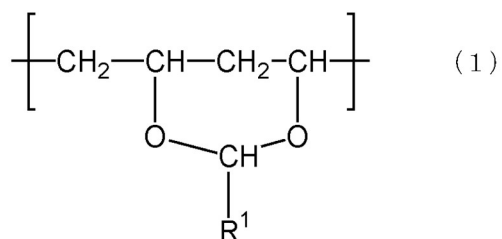
In particular, the molecular weight differential distribution value at the above-described Mz and Log M = 6.00 can be adjusted by changing the holding temperature, holding time, temperature rise time, and temperature rise
15 rate during the acetalization reaction, which are described below.

[0015]

The polyvinyl acetal resin of the present invention preferably contains an acetal group-containing
20 constitutional unit represented by the following formula (1), a hydroxy group-containing constitutional unit represented by the following formula (2), and an acetyl group-containing constitutional unit represented by the following formula (3).

25 [0016]

[Chem. 1]



[0017]

In the formula (1), R^1 represents a hydrogen atom or a C1-C20 alkyl group.

5 [0018]

When R^1 in the formula (1) is a C1-C20 alkyl group, examples of the alkyl group include methyl, ethyl, n-propyl, isopropyl, n-butyl, iso-butyl, sec-butyl, tert-butyl, pentyl, hexyl, heptyl, 2-ethylhexyl, octyl, nonyl, 10 decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, and octadecyl groups. Preferred among these are methyl and n-propyl groups.

[0019]

In the polyvinyl acetal resin of the present 15 invention, the lower limit of the amount of the acetal group-containing constitutional unit represented by the formula (1) (hereinafter also referred to as an "acetal group content") is preferably 50 mol%, and the upper limit thereof is preferably 83 mol%.

The polyvinyl acetal resin having an acetal group content of 50 mol% or more can have improved solubility in an organic solvent. The polyvinyl acetal resin having an acetal group content of 83 mol% or less can have excellent tensile strength.

The lower limit of the acetal group content is more preferably 55 mol%, and the upper limit thereof is more preferably 80 mol%. In other words, the acetal group content is preferably 50 to 83 mol%, more preferably 55 to 80 mol%.

The acetal group content can be measured by ^1H -NMR, for example.

Since an acetal group in a polyvinyl acetal resin is obtained by acetalizing two hydroxy groups in polyvinyl alcohol, the acetal group content is calculated by counting acetalized two hydroxy groups.

[0020]

In the polyvinyl acetal resin of the present invention, the lower limit of the amount of the hydroxy group-containing constitutional unit represented by the formula (2) (hereinafter also referred to as a "hydroxy group content") is preferably 18 mol%, and the upper limit thereof is preferably 40 mol%.

The polyvinyl acetal resin having a hydroxy group content of 18 mol% or more can have high toughness. The polyvinyl acetal resin having a hydroxy group content of 40 mol% or less can have sufficiently improved solubility in an organic solvent.

The lower limit of the hydroxy group content is more preferably 22 mol%, and the upper limit thereof is more preferably 38 mol%. In other words, the hydroxy group content is preferably 18 to 40 mol%, more preferably 22 to 38 mol%.

The hydroxy group content can be measured by ^1H -NMR, for example.

[0021]

In the polyvinyl acetal resin of the present invention, the lower limit of the amount of the acetyl group-containing constitutional unit represented by the formula (3) (hereinafter also referred to as an "acetyl group content") is preferably 0.1 mol%, and the upper limit thereof is preferably 22.0 mol%.

The polyvinyl acetal resin having an acetyl group content of 0.1 mol% or more can reduce a viscosity increase in a slurry composition for a ceramic green sheet caused by intramolecular or intermolecular hydrogen bonding between hydroxy groups in the polyvinyl acetal resin. The polyvinyl acetal resin having an acetyl group content of 22.0 mol% or less does not have too high flexibility and can have improved handleability.

The lower limit of the acetyl group content is more preferably 0.5 mol%, and the upper limit thereof is more preferably 15.0 mol%. In other words, the acetyl group content is preferably 0.1 to 22.0 mol%, more preferably 0.5 to 15.0 mol%.

The acetyl group content can be measured by ^1H -NMR, for example.

[0022]

The hydroxy group content relative to the Z average molecular weight of the polyvinyl acetal resin of the present invention (Hydroxy group content/Mz) is preferably 1.30×10^{-5} or more. When the Hydroxy group content/Mz is equal to or more than the lower limit, high dispersibility can be achieved.

The Hydroxy group content/Mz is more preferably 1.40×10^{-5} or more, still more preferably 1.50×10^{-5} or more, and is preferably 2.70×10^{-5} or less, more preferably 2.65×10^{-5} or less, still more preferably 2.60×10^{-5} or less. In other words, the Hydroxy group content/Mz is preferably 1.30×10^{-5} to 2.70×10^{-5} , more preferably 1.40×10^{-5} to

2.65×10^{-5} , still more preferably 1.50×10^{-5} to 2.60×10^{-5} .

[0023]

From the standpoint of maintaining mechanical
5 strength when producing a thin film ceramic green sheet,
the lower limit of the average degree of polymerization of
the polyvinyl acetal resin of the present invention is
preferably 500, more preferably 600. From the standpoint
of the solubility in an organic solvent and melt viscosity,
10 the upper limit thereof is preferably 10,000, more
preferably 9,000. In other words, the average degree of
polymerization is preferably 500 to 10,000, more preferably
600 to 9,000.

The average degree of polymerization of the polyvinyl
15 acetal resin is the same as that of the raw material
polyvinyl alcohol. The average degree of polymerization
can be measured in conformity with JIS K 6726.

[0024]

The polyvinyl acetal resin of the present invention
20 can be typically produced by acetalizing a polyvinyl
alcohol resin.

[0025]

The polyvinyl alcohol resin may be, for example, a
conventionally known polyvinyl alcohol resin such as a
25 resin produced by saponifying a polyvinyl acetate resin
with an alkali, an acid, aqueous ammonia, or the like.

The polyvinyl alcohol resin may be completely
saponified, but is not necessarily completely saponified
and may be a partially saponified polyvinyl alcohol resin
30 as long as the polyvinyl alcohol resin has at least one
unit having a hydroxy group diad for a meso or a racemo
position in at least one position of the main chain.
Examples of other polyvinyl alcohol resins that can be used
include copolymers of vinyl alcohol and a monomer
35 copolymerizable with vinyl alcohol such as ethylene-vinyl

alcohol copolymer resins and partially saponified ethylene-vinyl alcohol copolymer resins.

Examples of the polyvinyl acetate resin include ethylene-vinyl acetate copolymers.

5 [0026]

The polyvinyl alcohol resin preferably has a degree of saponification of 75 mol% or higher.

The degree of saponification is more preferably 76 mol% or higher and 99.4 mol% or lower, more preferably 78 mol% or higher and 98 mol% or lower. In other words, the
10 degree of saponification is preferably 76 to 99.4 mol%, more preferably 78 to 98 mol%.

Use of the polyvinyl alcohol resin allows the Mz to be within a predetermined range.

15 [0027]

The acetalization is preferably carried out in a water solvent, a solvent mixture containing water and an organic solvent compatible with water, or an organic solvent.

20 The organic solvent compatible with water may be, for example, an alcoholic organic solvent.

Examples of the organic solvent include alcoholic organic solvents, aromatic organic solvents, aliphatic ester solvents, ketone solvents, lower paraffin solvents,
25 ether solvents, amide solvents, and amine solvents.

Examples of the alcoholic organic solvents include methanol, ethanol, n-propanol, isopropanol, n-butanol, and tert-butanol.

30 Examples of the aromatic organic solvents include xylene, toluene, ethyl benzene, and methyl benzoate.

Examples of the aliphatic ester solvents include methyl acetate, ethyl acetate, butyl acetate, methyl propionate, ethyl propionate, methyl butyrate, ethyl butyrate, methyl acetoacetate, and ethyl acetoacetate.

35 Examples of the ketone solvents include acetone,

methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, methyl cyclohexanone, benzophenone, and acetophenone.

Examples of the lower paraffin solvents include hexane, pentane, octane, cyclohexane, and decane.

5 Examples of the ether solvents include diethyl ether, tetrahydrofuran, ethylene glycol dimethyl ether, ethylene glycol diethyl ether, and propylene glycol diethyl ether.

 Examples of the amide solvents include N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidone, and acetanilide.

10 Examples of the amine solvents include ammonia, trimethylamine, triethylamine, n-butylamine, di-n-butylamine, tri-n-butylamine, aniline, N-methylaniline, N,N-dimethylaniline, and pyridine.

15 These may be used alone or in admixture of two or more thereof. From the standpoint of the ability to dissolve resin and easy purification, particularly preferred among these are ethanol, n-propanol, isopropanol, and tetrahydrofuran.

20 [0028]

 The acetalization is preferably carried out in the presence of an acid catalyst.

 The acid catalyst is not limited, and examples thereof include mineral acids such as sulfuric acid, hydrochloric acid, nitric acid, and phosphoric acid, 25 carboxylic acids such as formic acid, acetic acid, and propionic acid, and sulfonic acids such as methanesulfonic acid, ethanesulfonic acid, benzenesulfonic acid, and p-toluenesulfonic acid. These acid catalysts may be used 30 alone, or two or more types of compounds may be used in combination. Preferred among these are hydrochloric acid, nitric acid, and sulfuric acid, and particularly preferred is hydrochloric acid.

 [0029]

35 The aldehyde used for the acetalization may be an

aldehyde having a C1-C10 chain aliphatic group, a C1-C10 cyclic aliphatic group, or a C1-C10 aromatic group. The aldehyde used may be a conventionally known aldehyde. The aldehyde used for the acetalization reaction is not
5 limited, and examples thereof include aliphatic aldehydes and aromatic aldehydes.

Examples of the aliphatic aldehydes include formaldehyde, acetaldehyde, propionaldehyde, n-butylaldehyde, isobutylaldehyde, n-valeraldehyde, n-
10 hexylaldehyde, 2-ethylbutylaldehyde, 2-ethylhexylaldehyde, n-heptylaldehyde, n-octylaldehyde, n-nonylaldehyde, n-decylaldehyde, and amylaldehyde.

Examples of the aromatic aldehydes include aromatic aldehydes such as benzaldehyde, cinnamaldehyde, 2-
15 methylbenzaldehyde, 3-methylbenzaldehyde, 4-methylbenzaldehyde, p-hydroxybenzaldehyde, m-hydroxybenzaldehyde, phenylacetaldehyde, and β -phenylpropionaldehyde.

These aldehydes may be used alone or in combination
20 of two or more thereof. Preferred among these aldehydes are formaldehyde, acetaldehyde, butylaldehyde, 2-ethylhexylaldehyde, and n-nonylaldehyde because they are excellent in acetalization reactivity and can give the resin to be prepared a sufficient internal plasticization
25 effect to impart favorable flexibility. More preferred are formaldehyde, acetaldehyde, and butylaldehyde because they can provide an adhesive composition particularly excellent in impact resistance and adhesiveness to metal.

[0030]

30 The amount of the aldehyde can be appropriately determined in accordance with the acetal group content of the aimed polyvinyl acetal resin. In particular, the amount is preferably 50 mol% or more and 95 mol% or less, more preferably 55 mol% or more and 90 mol% or less
35 relative to 100 mol% of the polyvinyl alcohol because the

acetalization reaction can be carried out efficiently and unreacted aldehyde is easily removable.

[0031]

5 The acetalization reaction is preferably carried out by raising the temperature at a predetermined temperature rise rate and then maintaining the temperature for a certain period of time.

10 The temperature rise time in the acetalization reaction is preferably 120 minutes or more and 420 minutes or less, more preferably 180 minutes or more and 360 minutes or less. In other words, the temperature rise time is preferably 120 to 420 minutes, more preferably 180 to 360 minutes.

15 The temperature rise rate is preferably 0.1°C/min or higher and 0.4°C/min or lower. In other words, the temperature rise rate is preferably 0.1 to 0.4°C/min.

20 Raising the temperature with the above-described temperature rise time and temperature rise rate allows the molecular weight differential distribution value at the above M_z and $\log M = 6.00$ to be within a predetermined range.

[0032]

25 The holding time in the acetalization reaction is preferably 1 hour or more and 10 hours or less, more preferably 2 hours or more and 9 hours or less, still more preferably 2.6 hours or more. In other words, the holding time is preferably 1 to 10 hours, more preferably 2 to 9 hours. Setting the holding time within the above range allows the M_z to be within a predetermined range.

30 The holding temperature in the acetalization reaction is preferably 30°C or higher and 80°C or lower, more preferably 40°C or higher and 70°C or lower. In other words, the holding temperature is preferably 30°C to 80°C, more preferably 40°C to 70°C. Setting the holding
35 temperature within the above range allows the molecular

weight differential distribution value at the above M_z and $\text{Log } M = 6.00$ to be within a predetermined range.

[0033]

5 The present invention also encompasses a resin composition for a ceramic green sheet containing the polyvinyl acetal resin of the present invention and a plasticizer.

10 The resin composition for a ceramic green sheet of the present invention may contain components such as an antioxidant, a surfactant, an ultraviolet absorber, and a defoamer, as long as the effects of the present invention are not impaired.

[0034]

15 The resin composition for a ceramic green sheet of the present invention may be produced by, for example, a method including: adding a plasticizer and other optional additives to a polyvinyl acetal resin obtained by acetalizing a polyvinyl alcohol resin with an aldehyde; and mixing them.

20 [0035]

The resin composition for a ceramic green sheet of the present invention may contain a plasticizer. Adding a plasticizer can significantly improve the mechanical strength and flexibility of the resulting ceramic green
25 sheet.

Examples of the plasticizer include: phthalate diesters such as dioctyl phthalate (DOP) and dibutyl phthalate (DBP); adipate diesters such as dioctyl adipate; and alkylene glycol diesters such as triethylene glycol-di-
30 2-ethylhexanoate, tetraethylene glycol-di-2-ethylhexanoate, triethylene glycol-di-2-ethylbutyrate, tetraethylene glycol-di-2-ethylbutyrate, tetraethylene glycol-di-heptanoate, and triethylene glycol-di-heptanoate.

[0036]

35 In the resin composition for a ceramic green sheet of

the present invention, the lower limit of the amount of the plasticizer relative to 100 parts by weight of the polyvinyl acetal resin is preferably 7 parts by weight, more preferably 8.5 parts by weight, and the upper limit thereof is preferably 18 parts by weight, more preferably 13.5 parts by weight.

[0037]

A slurry composition for a ceramic green sheet can be produced by mixing the resin composition for a ceramic green sheet of the present invention, an organic solvent, and ceramic powder.

[0038]

The organic solvent may be any organic solvent that can dissolve the polyvinyl acetal resin. Examples thereof include ketones such as acetone, methyl ethyl ketone, dipropyl ketone, and diisobutyl ketone. Examples also include alcohols such as methanol, ethanol, isopropanol, and butanol, and aromatic hydrocarbons such as toluene and xylene. Examples also include esters such as methyl propionate, ethyl propionate, butyl propionate, methyl butanoate, ethyl butanoate, butyl butanoate, methyl pentanoate, ethyl pentanoate, butyl pentanoate, methyl hexanoate, ethyl hexanoate, butyl hexanoate, 2-ethylhexyl acetate, and 2-ethylhexyl butyrate. Examples also include methyl cellosolve, ethyl cellosolve, butyl cellosolve, terpineol, dihydroterpineol, butyl cellosolve acetate, butyl carbitol acetate, terpineol acetate, and dihydroterpineol acetate. Particularly preferred are alcohols, ketones, aromatic hydrocarbons, and solvent mixtures thereof from the viewpoint of coatability and drying characteristics. More preferred among these are solvent mixtures of ethanol and toluene and solvent mixtures of methyl ethyl ketone and toluene.

[0039]

The amount of the organic solvent in the slurry

composition for a ceramic green sheet is set according to factors such as the type of the polyvinyl acetal resin used, and thus is not limited. The organic solvent in too small an amount is less likely to provide solubility
5 required for kneading. The organic content in too large an amount may excessively lower the viscosity of the slurry composition for a ceramic green sheet and deteriorate handleability in producing a ceramic green sheet. The organic solvent content is thus preferably 20% by weight or
10 more and 80% by weight or less.

[0040]

Examples of the ceramic powder include powders of an oxide or non-oxide of a metal or non-metal used in ceramic production. These powders each may be a powder of one
15 compound having a single composition or a mixture of compounds each having a single composition. For the constituent elements of the oxide or non-oxide of a metal, both the cation and anion may be composed of a single element or multiple elements. The oxide or non-oxide may
20 further contain an additive to improve the characteristics of the oxide or non-oxide. Specific examples thereof include oxides, carbides, nitrides, borides, and sulfides of Li, K, Mg, B, Al, Si, Cu, Ca, Sr, Ba, Zn, Cd, Ga, In, Y, lanthanoid, actinoid, Ti, Zr, Hf, Bi, V, Nb, Ta, W, Mn, Fe,
25 Co, and Ni.

Specific examples of a powder of an oxide containing multiple metal elements, which is typically called a multiple oxide, can be classified as follows by their crystalline structure. Examples of those having a
30 perovskite-type structure include NaNbO_3 , SrZrO_3 , PbZrO_3 , SrTiO_3 , BaZrO_3 , PbTiO_3 , and BaTiO_3 . Examples of those having a spinel-type structure include MgAl_2O_4 , ZnAl_2O_4 , CoAl_2O_4 , NiAl_2O_4 , and MgFe_2O_4 . Examples of those having an ilmenite-type structure include MgTiO_3 , MnTiO_3 , and FeTiO_3 .
35 Examples of those having a garnet-type structure include

GdGa₅O₁₂ and Y₆Fe₅O₁₂. In particular, the modified polyvinyl acetal resin of the present application exhibits high characteristics for a ceramic green sheet containing BaTiO₃ powder.

5 [0041]

The ceramic powder may have any average particle size. For example, for production of a thin ceramic green sheet (thickness of 5 μm or less), the average particle size is preferably 0.5 μm or less.

10 [0042]

The slurry composition for a ceramic green sheet may contain a different resin such as a polyvinyl acetal resin other than the polyvinyl acetal resin of the present invention, an acrylic resin, or ethylcellulose, as long as the effects of the present invention are not impaired. In such a case, the amount of the above polyvinyl acetal resin of the present invention relative to the entire binder resin is preferably 50% by weight or more.

[0043]

20 To the slurry composition for a ceramic green sheet may be added a dispersant, an antioxidant, an ultraviolet absorber, a surfactant, a filler, and/or the like, as needed. In some cases, a small amount of a different resin such as an acrylic resin or a urethane resin may be added.

25 [0044]

The method for producing the slurry composition for a ceramic green sheet is not limited. For example, the composition may be produced by a method including mixing the polyvinyl acetal resin of the present invention, the organic solvent, the ceramic powder, and optional various additives in any of various mixers such as a ball mill, a blender mill, or a triple roll mill.

[0045]

35 A ceramic green sheet can be obtained by applying the slurry composition for a ceramic green sheet and then

heating and drying the composition.

The ceramic green sheet may be used to produce a ceramic electronic component. For example, a ceramic electronic component may be produced by performing the steps of: applying a paste for an electrode layer to a surface of the ceramic green sheet; stacking and thermally pressure-bonding ceramic green sheets each provided with an electrode layer; and debinding and firing the obtained laminate.

10 [0046]

The method for applying the slurry composition for a ceramic green sheet is not limited. Examples thereof include a roll coater, a die coater, and a curtain coater. For other specific methods, conventionally known methods may be used.

15

[0047]

The ceramic electronic component is not limited. Examples thereof include multilayer ceramic capacitors, multilayer ceramic inductors, capacitors, piezoelectric actuators, multilayer varistors, multilayer thermistors, EMI filters, aluminum nitride multilayer boards, and alumina multilayer boards.

20

[0048]

In the method for producing the ceramic electronic component, the step of applying a paste for an electrode layer to a surface of the ceramic green sheet is performed.

25

The paste for an electrode layer may be produced by, for example, dissolving a resin such as a polyvinyl acetal resin, ethyl cellulose, or an acrylic resin as a binder resin in an organic solvent and dispersing conductive powder or the like in the solution. These resins may be used alone or in combination of two or more thereof. A paste for an electrode layer containing a polyvinyl acetal resin is preferred because such a paste has excellent adhesion to ceramic green sheets in the thermally pressure-

30

35

bonding step.

[0049]

In the method for producing the ceramic electronic component, after the above ceramic green sheet provided with an electrode layer is produced, at least one ceramic green sheet provided with an electrode layer is further produced in the same manner, and the ceramic green sheets are stacked and thermally pressure-bonded. The resulting laminate is debinded and fired, whereby a multilayer ceramic electronic component without problems such as sheet attack (phenomenon in which the solvent in the paste for an electrode layer dissolves the resin in the ceramic green sheets, causing defects) or cracks can be obtained.

The thermal pressure bonding step and the laminate debinding and firing step are not limited, and can be performed by conventionally known methods.

- Advantageous Effects of Invention

[0050]

The present invention can provide a polyvinyl acetal resin and a resin composition for a ceramic green sheet. The polyvinyl acetal resin and the resin composition can provide a ceramic green sheet which has high strength and is less susceptible to delamination and dimensional changes during drying. The polyvinyl acetal resin and the resin composition can also provide a multilayer ceramic capacitor with excellent reliability.

Furthermore, use of the polyvinyl acetal resin of the present invention can significantly improve the dispersibility and dispersion stability of the ceramic powder.

BRIEF DESCRIPTION OF DRAWINGS

[0051]

FIG. 1 shows an example of a molecular weight

differential distribution curve.

DESCRIPTION OF EMBODIMENTS

[0052]

5 The present invention is more specifically described in the following with reference to, but not limited to, examples.

[0053]

(Example 1)

10 Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 1,700, degree of saponification 99.0 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 120 g of
15 hydrochloric acid having a concentration of 35% by weight and 140 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.2°C/min (temperature rise time 250 min) and held at 70°C for three hours for an acetalization reaction. After the completion of the
20 reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin was obtained.

[0054]

(Production of resin composition for ceramic green sheet)

25 An amount of 1.25 parts by weight of the obtained polyvinyl acetal resin was added to 48.75 parts by weight of an ethanol/toluene solvent mixture (weight ratio 1:1). They were stirred for dissolution, whereby a resin composition for a ceramic green sheet was obtained.

30 [0055]

(Production of resin sheet)

 The obtained resin composition for a ceramic green sheet was applied using a coater onto a release-treated PET film to a dried thickness of 20 μm , and then heated and
35 dried at 70°C for 60 minutes, whereby a resin sheet was

obtained.

[0056]

(Preparation of slurry composition)

The obtained polyvinyl acetal resin (2 parts by
5 weight) and 2 parts by weight of dioctylphthalate (DOP)
were added to 96 parts by weight of an ethanol/toluene
solvent mixture (weight ratio 1:1), and they were stirred
for dissolution. Thus, a resin solution was prepared.

Separately, 3 parts by weight of a polyvinyl acetal
10 resin "BL-1" (produced by Sekisui Chemical Co., Ltd.) was
added to 40 parts by weight of an ethanol/toluene solvent
mixture (weight ratio 1:1), and they were stirred for
dissolution. Subsequently, to the obtained mixture was
added 100 parts by weight of barium titanate powder
15 (produced by Sakai Chemical Industry Co., Ltd., BT01), and
they were stirred in a bead mill (produced by AIMEX Co.,
Ltd., Ready Mill) for 180 minutes, whereby an inorganic
dispersion was prepared.

To the obtained inorganic dispersion was added 100
20 parts by weight of the resin solution, and they were
stirred in the bead mill, whereby a slurry composition was
obtained. During the stirring, the slurry composition was
sampled every five minutes, a 0.1 parts by weight portion
of the slurry composition was added to 10 parts by weight
25 of an ethanol/toluene solvent mixture (weight ratio 1:1),
and they were stirred with an ultrasonic disperser
(produced by SND Co., Ltd., US-303) to prepare a solution
for dispersion evaluation. The particle size distribution
was measured using a laser diffraction particle size
30 distribution analyzer (produced by HORIBA, Ltd., LA-910).
Stirring was stopped when the D50 value of the particle
size distribution reached 1.0 μm .

[0057]

(Example 2)

35 Pure water (3000 g) was added to 300 g of a polyvinyl

alcohol resin (average degree of polymerization 3,000, degree of saponification 98.9 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 120 g of hydrochloric acid having a concentration of 35% by weight and 140 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.2°C/min (temperature rise time 250 min) and held at 70°C for three hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0058]

(Example 3)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 5,000, degree of saponification 98.9 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 120 g of hydrochloric acid having a concentration of 35% by weight and 140 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.2°C/min (temperature rise time 250 min) and held at 70°C for two hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0059]

(Example 4)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 9,000,

degree of saponification 98.9 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 120 g of hydrochloric acid having a concentration of 35% by weight and 140 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.2°C/min (temperature rise time 250 min) and held at 70°C for three hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0060]

15 (Example 5)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 1,700, degree of saponification 98.8 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 120 g of hydrochloric acid having a concentration of 35% by weight and 140 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.16°C/min (temperature rise time 250 min) and held at 60°C for three hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0061]

(Example 6)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 800, degree of saponification 98.8 mol%). They were stirred at 90°C

for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 150 g of hydrochloric acid having a concentration of 35% by weight and 145 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.16°C/min (temperature rise time 250 min) and held at 60°C for three hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0062]

(Comparative Example 1)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 300, degree of saponification 99.0 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 150 g of hydrochloric acid having a concentration of 35% by weight and 145 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.5°C/min (temperature rise time 10 min) and held at 25°C for four hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0063]

(Comparative Example 2)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 500, degree of saponification 98.5 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was

cooled to 20°C. To the solution were added 150 g of hydrochloric acid having a concentration of 35% by weight and 145 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.5°C/min (temperature rise time 5 10 min) and held at 25°C for three hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry 10 composition were obtained.

[0064]

(Comparative Example 3)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 800, degree 15 of saponification 99.0 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 150 g of hydrochloric acid having a concentration of 35% by weight and 145 g of n-butyraldehyde. The mixture was heated at a 20 temperature rise rate of 0.7°C/min (temperature rise time 7 min) and held at 25°C for three hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were 25 performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0065]

30 (Comparative Example 4)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 9,000, degree of saponification 99.0 mol%). They were stirred at 90°C for about two hours for dissolution. This solution 35 was cooled to 20°C. To the solution were added 150 g of

hydrochloric acid having a concentration of 35% by weight and 145 g of n-butyraldehyde. The mixture was heated at a temperature rise rate of 0.7°C/min (temperature rise time 10 min) and held at 25°C for 2.5 hours for an acetalization
5 reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were
10 obtained.

[0066]

(Comparative Example 5)

Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 8,800,
15 degree of saponification 99.0 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 150 g of hydrochloric acid having a concentration of 35% by weight and 150 g of n-butyraldehyde. The mixture was heated at a
20 temperature rise rate of 0.7°C/min (temperature rise time 7 min) and held at 25°C for 2.5 hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of
25 a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0067]

(Comparative Example 6)

30 Pure water (3000 g) was added to 300 g of a polyvinyl alcohol resin (average degree of polymerization 800, degree of saponification 98.7 mol%). They were stirred at 90°C for about two hours for dissolution. This solution was cooled to 20°C. To the solution were added 150 g of
35 hydrochloric acid having a concentration of 35% by weight

and 160 g of n-butyraldehyde. The mixture was held at 20°C for three hours for an acetalization reaction. After the completion of the reaction, neutralization, washing with water, and drying were performed by conventional methods, whereby white powder of a polyvinyl acetal resin, a resin composition for a ceramic green sheet, a resin sheet, and a slurry composition were obtained.

[0068]

(Evaluation)

10 The polyvinyl acetal resins, resin compositions for a ceramic green sheet, resin sheets, and slurry compositions obtained in the examples and the comparative examples were evaluated as follows. Table 1 shows the results.

[0069]

15 (1) Evaluation of polyvinyl acetal resin

(1-1) Acetal group content, hydroxy group content, and acetyl group content

20 The obtained polyvinyl acetal resin was subjected to ¹H-NMR analysis using a spectrometer AV400 model (produced by Bruker Corporation), and the acetal group content, hydroxy group content, and acetyl group content were calculated.

25 The obtained polyvinyl acetal resin was dissolved in DMSO-D₆ at a concentration of 1.6% by weight to prepare a measurement solution. The solution was subjected to ¹H-NMR analysis at 80°C.

[0070]

(1-2) Molecular weight differential distribution value at M_z and Log M = 6.00

30 The obtained polyvinyl acetal resin was dissolved in tetrahydrofuran (THF) at a concentration of 0.2% by weight, and the solution was subjected to measurement using a GPC apparatus HLC-8220 (produced by Tosoh Corporation). From the measurement results, the Z average molecular weight M_z was calculated using a molecular weight calibration curve

35

prepared using monodisperse polystyrene standard samples.

From the obtained molecular weight differential distribution curve, the molecular weight differential distribution value at $\text{Log } M = 6.00$ was measured.

5 The column used was TSKgel Super HZ (produced by Tosoh Corporation).

[0071]

(2) Evaluation of resin sheet

(2-1) Tensile modulus of elasticity, elongation at break,
10 and stress at break

The stress at break (MPa), elongation at break (%), and tensile modulus of elasticity (MPa) of the obtained resin sheet were measured in conformity with JIS K 7113 using a tensile tester (produced by Shimadzu Corporation,
15 AUTOGRAPH AGS-J) at a tensile speed of 20 mm/min.

[0072]

(3) Evaluation of slurry composition

(3-1) Dispersibility

(Preparation of solution for dispersion evaluation)

20 First, 0.1 parts by weight of the slurry composition was added to 10 parts by weight of an ethanol/toluene solvent mixture (weight ratio 1:1), and the mixture was stirred with an ultrasonic disperser (produced by SND Co., Ltd., US-303) to prepare a solution for evaluation of
25 dispersibility.

[0073]

(Evaluation of dispersibility)

The particle size distribution of the obtained solution for evaluation of dispersibility was measured 60
30 minutes after the end of stirring.

The particle size distribution was measured using a laser diffraction particle size distribution analyzer (produces by HORIBA, Ltd., LA-910) to determine the average particle size.

35 [0074]

(3-2) Dispersion stability

The solution for evaluation of dispersibility obtained in (3-1) above was left to stand at 23°C for one week. Thereafter, the solution was subjected to measurement of the particle size distribution to determine the average particle size.

[0075]

(4) Evaluation of ceramic green sheet

(Preparation of ceramic green sheet)

The obtained slurry composition was applied to a release-treated PET film to a dried thickness of 20 μm using a coater. The composition was heated and dried, whereby a ceramic green sheet was prepared.

[0076]

(4-1) Tensile modulus of elasticity, elongation at break, and stress at break

(Preparation of ceramic green sheets)

One part by weight of a polyvinyl acetal resin (produced by Sekisui Chemical Co., Ltd., BL-1) was added to a solvent mixture of 20 parts by weight of toluene and 20 parts by weight of ethanol, and they were stirred for dissolution. Subsequently, to the obtained solution was added 100 parts by weight of barium titanate powder (produced by Sakai Chemical Industry Co., Ltd., BT01, average particle size 0.1 μm), followed by stirring in a bead mill (produced by AIMEX Co., Ltd., Ready Mill) for 180 minutes, whereby an inorganic dispersion was prepared.

To the obtained inorganic dispersion was added the resin composition for a ceramic green sheet obtained in any of the examples and comparative examples. After stirring in a bead mill for 90 minutes, the mixture was applied to a release-treated PET film using a coater to a dried thickness of 20 μm . Then, the mixture was heated and dried at 40°C for 30 minutes. The PET film was removed, whereby a ceramic green sheet was obtained.

The stress at break (MPa), tensile modulus of elasticity (MPa), and elongation at break (%) of the obtained ceramic green sheet were measured in conformity with JIS K 7113 using a tensile tester (produced by Shimadzu Corporation, AUTOGRAPH AGS-J) at a tensile speed of 20 mm/min.

[0077]

(4-2) Section state

The fracture surface after the measurement of "(4-1) Tensile modulus of elasticity, elongation at break, and stress at break" was observed with an SEM, and evaluated in accordance with the following criteria.

- oo (Excellent): The fracture surface was not chipped, cracked, or scratched.
- 15 o (Good): The fracture surface was not chipped or cracked, but was scratched.
- Δ (Fair): The fracture surface was not chipped but was cracked.
- × (Poor): The fracture surface was chipped, and separation
- 20 between sheets occurred.

[0078]

(4-3) Dimensional change rate

A ceramic green sheet was produced as in "(4-1) Tensile modulus of elasticity, elongation at break, and stress at break". The obtained ceramic green sheet was dried at 70°C for three hours. The dimensional change rate before and after the drying at 70°C was calculated and evaluated in accordance with the following criteria.

- oo (Excellent): not higher than 2%
- 30 o (Good): higher than 2% and not higher than 3%
- Δ (Fair): higher than 3% and not higher than 4%
- × (Poor): higher than 4 %

[0079]

[Table 1]

	Production method		Polyvinyl acetal resin						Evaluation									
	Holding temperature [°C]	Holding time [hr]	Acetal group content [mol%]	Acetyl group content [mol%]	Hydroxy group content [mol%]	Mz	Molecular weight differential distribution value at Log M= 6.00	Hydroxy group content /Mz*	Resin sheet			Slurry composition			Ceramic green sheet evaluation			
									Stress at break [MPa]	Elongation at break [%]	Tensile modulus of elasticity [MPa]	Dispersibility (after 60 minutes) [μm]	Dispersion stability [μm]	Stress at break [MPa]	Tensile modulus of elasticity [MPa]	Elongation at break [%]	Section state evaluation	Dimensional change rate
Example 1	70	3	65.2	1.0	33.8	1,304,000	25.15	2.59E-05	33	188	550	0.221	0.332	33	1050	23	OO	OO
Example 2	70	3	64.8	1.0	34.2	1,290,880	49.22	2.65E-05	35	200	745	0.355	0.389	42	1125	28	OO	OO
Example 3	70	3	65.3	1.1	33.6	1,785,533	71.34	1.88E-05	50	242	810	0.412	0.443	48	1258	33	O	O
Example 4	70	3	64.7	1.1	34.2	2,293,459	93.48	1.49E-05	70	320	740	0.455	0.488	55	1458	41	O	O
Example 5	60	3	64.8	1.0	34.2	1,289,300	20.10	2.65E-05	34	178	568	0.210	0.348	33	1011	25	O	O
Example 6	60	3	66.0	1.2	32.8	859,233	9.770	3.82E-05	38	155	220	0.220	0.278	28	910	18	O	OO
Comparative Example 1	25	4	65.0	1.0	34.0	126,809	0.23	2.68E-04	25	90	100	0.210	0.648	18	825	13	x	x
Comparative Example 2	25	3	64.9	1.0	34.1	652,980	2.99	5.22E-05	27	135	130	0.220	0.621	20	880	15	x	x
Comparative Example 3	25	3	64.0	1.0	35.0	789,483	4.95	4.43E-05	30	180	200	0.236	0.667	25	996	18	Δ	Δ
Comparative Example 4	25	2.5	64.5	1.0	34.5	2,498,500	117.05	1.38E-05	55	236	822	0.882	1.533	29	998	20	x	x
Comparative Example 5	25	2.5	64.5	1.0	34.5	2,601,554	120.01	1.33E-05	57	237	823	0.902	1.556	28	988	21	x	x
Comparative Example 6	20	3	67.5	1.3	31.2	772,321	4.36	4.04E-05	23	191	177	0.251	0.601	20	882	16	Δ	x

* : E·OX = 10^x

INDUSTRIAL APPLICABILITY

[0080]

The present invention can provide a polyvinyl acetal resin and a resin composition for a ceramic green sheet.

5 The polyvinyl acetal resin and the resin composition can provide a ceramic green sheet in which ceramic powder has excellent dispersibility and excellent dispersion stability and which has high strength and is less susceptible to delamination and dimensional changes during drying. The

10 polyvinyl acetal resin and the resin composition can also provide a multilayer ceramic capacitor with excellent reliability.

CLAIMS

Claim 1. A polyvinyl acetal resin having a Z average
molecular weight (Mz) of 800,000 or more and 2,300,000 or
5 less and a molecular weight differential distribution value
at Log M = 6.00 of 8.00 or more and 95.0 or less.

Claim 2. The polyvinyl acetal resin according to
claim 1,
10 wherein a hydroxy group content relative to the Z
average molecular weight (Hydroxy group content/Z average
molecular weight) is 1.30×10^{-5} or more and 2.70×10^{-5} or
less.

15 Claim 3. The polyvinyl acetal resin according to
claim 1 or 2,
wherein the acetal group content is 50 to 83 mol%.

Claim 4. A resin composition for a ceramic green
20 sheet, the resin composition comprising:
the polyvinyl acetal resin according to claim 1 or 2;
and
a plasticizer.