

RESIN COMPOSITION FOR CLEANING DIE

BACKGROUND OF THE INVENTION

[Technical Field]

[0001] The present invention relates to a resin composition for cleaning a die.

[Background Art]

[0002] When a sealing molding operation of an integrated circuit, an LED element, or the like is continued for a long time using a sealing molding material containing a thermosetting resin composition, of which an epoxy resin, a silicone resin, a phenolic resin, a polyimide resin, and the like are representative, a stain originating from the sealing molding material adheres to the inner surface of a molding die. If the stain adhering to the inner surface of the molding die is left unattended to, this results in a defect whereby an impurity adheres to the surface of a sealing-molded product such as an integrated circuit or an LED element. Prevention of this kind of defect requires the removal of the stain adhering to the inner surface of the molding die during the sealing molding step. Specifically, a resin composition for cleaning a die is molded instead of the sealing molding material at a rate of several shots for every several hundred shots of sealing molding operation, whereby the stain on the inner surface of the molding die is removed.

[0003] Much research related to resin compositions for cleaning dies has been carried out hitherto. As a specific example of a resin composition for cleaning a die, a resin composition for cleaning a die has been disclosed that includes an amino-based resin such as a melamine resin, and a mineral powder of which the maximum particle diameter and average particle diameter are controlled (e.g., see Japanese Patent Application Laid-Open (JP-A) No. 2003-62835). The resin composition for cleaning a die disclosed in Patent Document 1 is imparted with favorable fluidity by adjusting the content of mineral powder having a maximum particle diameter of 180 μm or less and a particle diameter of 100 μm or more to 1 mass% or less with respect to the total amount of the mineral powder, and by adjusting the content of the mineral powder to from 5 to 30 mass% with respect to the total amount of the resin composition for cleaning a die, and the resin composition is spread into every nook and cranny of voids in a die, whereby the resin composition for cleaning a die captures any impurities.

SUMMARY OF INVENTION

[Technical Problem]

[0004] In recent years, with the improved performance of electronic instruments and the like, the sealing molding shapes and structures of integrated circuits, LED elements, and the like have been diversified and made more precise. Therefore, it has also been required that the shapes and structures of molding dies be diversified and made more precise. When cleaning this kind of molding die, it is required that stains are removed from every nook and cranny of any cavities, including corner portions and narrow void portions in which stains tend to remain, in the molding die.

However, conventional resin compositions for cleaning dies, including the resin composition for cleaning a die disclosed in JP-A No. 2003-62835 as described above, have insufficient effects in terms of adaptability to the shapes and structures of molding dies that have been diversified and made more precise as described above, and leave room for improvement.

[0005] A stain adhering to the inner surface of a molding die and originating from a sealing molding material can be easily removed using a resin composition for cleaning a die in a case in which the inner surface of the molding die is in a nearly-smooth state. The inner surface of the molding die is usually subjected to plating treatment.

However, conventional resin compositions for cleaning dies have caused a plating-treated surface to be chipped or roughening of a surface state to occur because a filler contained in the resin composition for cleaning a die has generated an abrasion or a flaw in the inner surface of a molding die. When a flaw is left in the inner surface of the molding die, this causes a stain to remain on the inner surface of the molding die, and also results in deterioration of die-cleaning operability. Abrasion of gate portions in the cavities of the molding die requires repairs or replacement of the molding die.

[0006] The invention was accomplished in view of the circumstances described above, and is directed at providing a resin composition for cleaning a die, with which every nook and cranny of the cavities of a molding die can be sufficiently cleaned, and abrasion and flaws are suppressed at the inner surface and gate portions of the molding die.

[Solution to Problem]

[0007] A first embodiment of the invention is a resin composition for cleaning a die, including at least a melamine-based resin, and an inorganic filler having an average particle diameter of from 4 to 12 μm , a standard deviation of particle diameter of 10 μm or less, an average aspect ratio of particle diameter of from 1 to 1.3, and a standard deviation of aspect ratio of particle diameter of 0.5 or less.

It is preferable that this resin composition for cleaning a die further includes a metal

salt of a saturated fatty acid, including a saturated fatty acid having from 14 to 18 carbon atoms and a metal selected from calcium, zinc, or magnesium.

[0008] In this resin composition for cleaning a die, the inorganic filler is preferably at least one selected from silicon carbide, silicon oxide, titanium carbide, titanium oxide, boron carbide, boron oxide, aluminum oxide, magnesium oxide, or calcium oxide, and is more preferably at least one selected from silicon oxide or aluminum oxide.

[0009] The above-described resin composition for cleaning a die is preferably used in transfer molding.

[Advantageous Effects of Invention]

[0010] According to the resin composition for cleaning a die of the invention, every nook and cranny of the cavities of a molding die can be sufficiently cleaned, and abrasion and flaws are suppressed at the inner surface and gate portions of the molding die.

BRIEF DESCRIPTION OF DRAWINGS

[0011] Fig. 1 is a graph that indicates relationships between the particle diameters and frequencies of inorganic fillers included in the resin composition for cleaning a die according to an embodiment of the invention.

Fig. 2 is a graph that indicates relationships between the aspect ratios of particle diameters and frequencies of inorganic fillers included in the resin composition for cleaning a die according to an embodiment of the invention.

Fig. 3 is a graph that indicates relationships between the approximate values of volumes and frequencies of inorganic fillers included in the resin composition for cleaning a die according to an embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

[0012] Specific embodiments of the invention are explained in detail below; however, the invention is not limited to the embodiments below at all, but can be modified, if appropriate, and carried out within the scope of the object of the invention.

[0013] In recent years, with the higher performance of electronic instruments and the like, the shapes and structures of sealing molding dies for integrated circuits, LED elements, and the like have also been diversified and made more precise. In cleaning of a molding die, it is required that a stain is removed in every nook and cranny of the cavities, including corner portions and narrow void portions in which stains tend to remain, in the molding die.

However, conventional resin compositions for cleaning dies have not been able to adapt to the shapes and structures of dies that have been diversified and made more precise. In particular,

it has been difficult to remove stains adhering to corner portions or narrow void portions to a favorable degree. A filler contained in a conventional resin composition for cleaning a die has caused abrasion or flaws to be generated at the inner surface of a molding die. When the flaw is left at the inner surface of the molding die, this causes a stain to remain on the inner surface of the molding die, and results in deterioration of die-cleaning operability. Abrasion of gate portions in the cavities of the molding die requires repairs or replacement of the molding die.

The invention is significant in that selection of at least a melamine-based resin and an inorganic filler as components and control of the average particle diameter, standard deviation of particle diameter, average aspect ratio of particle diameter, and standard deviation of aspect ratio of particle diameter of the inorganic filler make it possible to realize provision of a resin composition for cleaning a die, with which every nook and cranny of the cavities of a molding die can be sufficiently cleaned, and abrasion and flaws are suppressed at the inner surface and gate portions of the molding die.

[0014] [Resin Composition for Cleaning Die]

The resin composition for cleaning a die of the invention includes at least a melamine-based resin and an inorganic filler having an average particle diameter of from 4 to 12 μm , a standard deviation of particle diameter of 10 μm or less, an average aspect ratio of particle diameter of from 1 to 1.3, and a standard deviation of aspect ratio of particle diameter of 0.5 or less. The resin composition for cleaning a die of the invention further includes a saturated fatty acid or a metal salt thereof, an organic filler, in addition, an additive, and the like, if necessary.

The resin composition for cleaning a die of the invention is preferably used for removing a stain on the inner surface of a molding die, particularly a stain originating from a sealing molding material containing a thermosetting resin composition of which an epoxy resin, a silicone resin, a phenolic resin, a polyimide resin, or the like is representative.

[0015] (Melamine-Based Resin)

The resin composition for cleaning a die of the invention includes a melamine-based resin. In the invention, the "melamine-based resin" refers to a melamine resin, a melamine-phenol co-condensate, or a melamine-urea co-condensate. More specifically, in the invention, the "melamine-based resin" refers to methylol melamine which is a reactant of melamine with formaldehyde, or a reactant of melamine, phenol, or urea with methylol melamine. In the invention, one or more are selected from the above, and used.

The resin composition for cleaning a die of the invention exhibits excellent cleaning performance for a stain on the inner surface of a molding die because of including the

melamine-based resin. The melamine-based resin has a methylol group having a high polarity. In the invention, the methylol group having a high polarity of the melamine-based resin can be considered to act on a stain originating from a sealing molding material containing a thermosetting resin composition, whereby an excellent cleaning effect is exerted. The resin composition for cleaning a die of the invention can also be considered to exhibit stable cleaning performance even at from around 160 to 190°C as general temperature in cleaning of a molding die since the melamine-based resin is stable against heat.

[0016] The above-described melamine resin is a condensate of a triazine and an aldehyde. Examples of triazines include melamine, benzoguanamine, acetoguanamine, and the like. Examples of aldehydes include formaldehyde, paraformaldehyde, acetaldehyde, and the like.

In the invention, the melamine resin preferably has a molar ratio of repeating unit derived from the triazine and repeating unit derived from the aldehyde, of from 1:1.2 to 1:4.

The melamine-phenol co-condensate is a co-condensate of a triazine, a phenol, and an aldehyde. Examples of phenols include phenol, cresol, xyleneol, ethylphenol, butylphenol, and the like.

In the invention, the melamine-phenol co-condensate preferably has a molar ratio of repeating unit derived from the triazine, repeating unit derived from the phenol, and repeating unit derived from the aldehyde, of from 1:0.3:1 to 1:1:3.

The melamine-urea co-condensate is a co-condensate of a triazine, a urea, and an aldehyde. Examples of ureas include urea, thiourea, ethylene urea, and the like.

[0017] The melamine-based resin in the invention can be produced by a known method. For example, a melamine crystal and formaldehyde are stirred under conditions of a molar ratio of from 1:1.2 to 1:4, a reaction temperature of from 80 to 90°C, and a pH of from 7 to 7.5, and are allowed to react for time before a 3 mass% aqueous solution of a reactant becomes cloudy at 60°C, NaOH is put, and the resultant is cooled, whereby the melamine resin can be obtained. In the invention, a melamine-based resin produced by such a known method as described above may be used, or a commercially available melamine-based resin may be used.

[0018] A content of the melamine-based resin in the invention is preferably from 60 to 80 parts by mass, more preferably from 65 to 75 parts by mass, with respect to 100 parts by mass of the total solid content of the resin composition for cleaning a die. In a case in which the content of the melamine-based resin is in the above-described range, the resin composition for cleaning a die exhibits excellent cleaning performance since the strength of the resin composition for cleaning a die is kept suitable in molding, and curing also appropriately proceeds during cleaning.

[0019] (Inorganic Filler)

The resin composition for cleaning a die of the invention includes an inorganic filler. Examples of the inorganic filler in the invention include silicon carbide, silicon oxide, titanium carbide, titanium oxide, boron carbide, boron oxide, aluminum oxide, magnesium oxide, calcium oxide, calcium carbonate, and the like. In the invention, the inorganic fillers may be used singly, or in combination of plural kinds thereof.

[0020] It is preferable that the inorganic filler in the invention is at least one selected from silicon carbide, silicon oxide, titanium carbide, titanium oxide, boron carbide, boron oxide, aluminum oxide, magnesium oxide, or calcium oxide. The inorganic fillers are preferred from the viewpoint of being favorably mixed with the melamine-based resin in the case of producing the resin composition for cleaning a die.

In the invention, a more preferred inorganic filler is at least one selected from silicon oxide, titanium oxide, or aluminum oxide, a still more preferred inorganic filler is at least one selected from silicon oxide and aluminum oxide, and a particularly preferred inorganic filler is silicon oxide.

Silicon oxide, titanium oxide, and aluminum oxide are preferred because of having appropriate hardness, and of making it possible to suppress abrasion and flaws at the inner surface and gate portions of a die, depending on the material and state of the die, and therefore on circumstances. Temperature in the case of cleaning a die is usually from 160 to 190°C, and silicon oxide, titanium oxide, and aluminum oxide are preferred because of being thermally stable at around the temperature.

[0021] Silicon carbide, silicon oxide, titanium carbide, titanium oxide, boron carbide, boron oxide, aluminum oxide, magnesium oxide, and calcium oxide, which are the inorganic fillers exemplified above, have hardnesses (new Mohs hardnesses) of 13, 8, 9, 8, 14, 3, 12, 4, and 3, respectively.

[0022] The inorganic filler in the invention has an average particle diameter of from 4 to 12 μm , a standard deviation of particle diameter of 10 μm or less, an average aspect ratio of particle diameter of from 1 to 1.3, and a standard deviation of aspect ratio of particle diameter of 0.5 or less.

The resin composition for cleaning a die of the invention enables sufficient cleaning even in corner portions in the cavities of a molding die and suppresses abrasion or flaws at the inner surface and gate portions of the molding die because of including the inorganic filler having an average particle diameter, a standard deviation of particle diameter, an average aspect ratio of particle diameter, and a standard deviation of aspect ratio of particle diameter in the specific numerical value ranges.

[0023] The inorganic filler in the invention has an average particle diameter in a range of from 4 to 12 μm , preferably in a range of 6 to 10 μm . It can be considered to be difficult for an inorganic filler having a significantly small average particle diameter to exert cleaning performance in the cavities of a molding die because the inorganic filler has a small mass and a small surface area.

In the invention, the inorganic filler exhibits sufficient cleaning performance for a stain at the inner surface of a molding die because of having an average particle diameter of 4 μm or more. In the invention, sufficient cleaning can be performed even in corner portions in the cavities of the molding die, and abrasion and flaws are suppressed at the inner surface and gate portions of the molding die, since the inorganic filler has an average particle diameter of 12 μm or less.

[0024] The inorganic filler in the invention has a standard deviation of particle diameter of 10 μm or less. The large standard deviation of particle diameter of the inorganic filler results in deterioration of fluidity of the resin composition for cleaning a die in cleaning, and in deterioration of a cleaning effect in corner portions in the cavities of a molding die in which stains tend to remain.

In the invention, since the inorganic filler has a standard deviation of particle diameter of 10 μm or less, the fluidity of the resin composition for cleaning a die is maintained in cleaning, whereby sufficient cleaning is enabled even in corner portions in the cavities of a molding die.

[0025] The inorganic filler in the invention has an average aspect ratio of particle diameter in a range of from 1 to 1.3, preferably in a range of 1 to 1.25, more preferably in a range of 1.10 to 1.23. The large average aspect ratio of particle diameter of the inorganic filler results in deterioration of the fluidity of the resin composition for cleaning a die in cleaning, in deterioration of a cleaning effect in corner portions in the cavities of a molding die in which stains tend to remain, and in easy generation of abrasion and flaws at the inner surface and gate portions of the molding die.

In the invention, since the inorganic filler has an average aspect ratio of particle diameter of 1.3 or less, the fluidity of the resin composition for cleaning a die is maintained in cleaning, whereby sufficient cleaning is enabled even in corner portions in the cavities of a molding die, and abrasion and flaws are suppressed at the inner surface and gate portions of the molding die.

[0026] The inorganic filler in the invention has a standard deviation of aspect ratio of particle diameter of 0.5 or less, preferably 0.45 or less. The large standard deviation of aspect ratio of particle diameter of the inorganic filler results in deterioration of the fluidity of

the resin composition for cleaning a die in cleaning, in deterioration of a cleaning effect in corner portions in the cavities of a molding die in which stains tend to remain, and in easy generation of abrasion and flaws at the inner surface and gate portions of the molding die.

In the invention, since the inorganic filler has a standard deviation of aspect ratio of particle diameter of 0.5 or less, and the inorganic filler has a substantially uniform shape, the fluidity of the resin composition for cleaning a die is maintained in cleaning, whereby sufficient cleaning is enabled even in corner portions in the cavities of a molding die, and abrasion and flaws are suppressed at the inner surface and gate portions of the molding die.

[0027] "Particle diameter" in the invention is a value measured by a method described below. An inorganic filler is photographed at a magnification of 1500 times using an electron microscope (JSM-5510, manufactured by JEOL Ltd.). The photographing is performed such that about 30 particles of the inorganic filler are included in one visual field, and each of the major diameters (X) and minor diameters (Y) of 150 particles of the inorganic filler in total included in different five visual fields is measured five times. The minor diameters (Y) are taken to be perpendicular to the major diameters (X). The average values of the five-time measured values of the major diameters (X) and the minor diameters (Y) are determined, and substituted into Expression 1 described below, and the particle diameter of one particle of the inorganic filler is calculated.

Particle diameter = ((average value of five-time measured values of X) + (average value of five-time measured values of Y)) / 2

Expression 1

[0028] "Average particle diameter" in the invention is the average value of the particle diameters of the 150 particles of the inorganic filler measured by the above-described method. "Standard deviation of particle diameter" in the invention is the standard deviation of the particle diameters of the 150 particles of the inorganic filler measured by the method.

[0029] "Aspect ratio of particle diameter" in the invention is a value measured by a method described below. An inorganic filler is photographed at a magnification of 1500 times using an electron microscope (JSM-5510, manufactured by JEOL Ltd.). The photographing is performed such that about 30 particles of the inorganic filler are included in one visual field, and each of the major diameters (X) and minor diameters (Y) of 150 particles of the inorganic filler in total included in different five visual fields is measured five times. The minor diameters (Y) are taken to be perpendicular to the major diameters (X). The average values of the five-time measured values of the major diameters (X) and the minor diameters (Y) are determined, and substituted into Expression 2 described below, and the aspect ratio of the particle diameter of one particle of the inorganic filler is calculated. In Expression 2 described below, major diameter (X) $\geq$ minor diameter (Y) holds.

Aspect ratio of particle diameter = (average value of five-time measured values of X)
/ (average value of five-time measured values of Y) Expression 2

[0030] According to the measurement method defined as described above, the aspect ratio of the particle diameter is 1 in a case in which the major diameter (X) is equal to the minor diameter (Y). According to the measurement method defined as described above, the aspect ratio of the particle diameter is not a value of less than 1. The shape of the inorganic filler in the invention is generally spherical (confirmed with an electron microscope). Accordingly, the aspect ratio of particle diameter of being closer to 1 means that the shape of the inorganic filler is more spherical. The inorganic filler used in the resin composition for cleaning a die, which inorganic filler is fractured, i.e., has an indefinite shape, is usually used. The fractured inorganic filler has an aspect ratio of particle diameter of, e.g., 1.5 or more.

[0031] "Average aspect ratio" in the invention is the average value of the aspect ratios of the particle diameters of the 150 particles of the inorganic filler measured by the method.

"Standard deviation of aspect ratio" in the invention is the standard deviation of the aspect ratios of the particle diameters of the 150 particles of the inorganic filler measured by the method.

[0032] The inorganic filler in the invention satisfies the conditions of the average particle diameter, the standard deviation of particle diameter, the average aspect ratio of particle diameter, and the standard deviation of aspect ratio of particle diameter described above, and preferably has a maximum particle diameter of 100 μm or less, more preferably 75 μm or less, depending on the shape of a die. The maximum particle diameter of the inorganic filler of 100 μm or less is preferred because of resulting in enhancement of a cleaning effect in corner portions in the cavities of a molding die.

[0033] Examples of commercially available products of the preferred inorganic filler satisfying the conditions of the average particle diameter, the standard deviation of particle diameter, the average aspect ratio of particle diameter, and the standard deviation of aspect ratio of particle diameter described above include, e.g., fused silica such as HS203 (manufactured by Nippon Steel Materials Co., Ltd. Micron Co.), HS205 (manufactured by Nippon Steel Materials Co., Ltd. Micron Co.), TS10-141 (manufactured by Nippon Steel Materials Co., Ltd. Micron Co.), FB7SDC (manufactured by DENKI KAGAKU KOGYO KABUSHIKI KAISHA), SE-40 (manufactured by Tokuyama Corporation), SE-15 (manufactured by Tokuyama Corporation), or SE-8T (manufactured by Tokuyama Corporation); alumina of CB-P10 (manufactured by Showa Denko K.K.); and the like.

[0034] A content of the inorganic filler in the invention is preferably 10 to 30 parts by mass, more preferably 15 to 25 parts by mass, with respect to 100 parts by mass of the total solid

content of the resin composition for cleaning a die. In a case in which the content of the inorganic filler is in the range, operability becomes favorable in peeling from a die after cleaning, and performance for cleaning the inner surface of a molding die also becomes favorable, since the strength of the resin composition for cleaning a die is maintained suitable in molding.

[0035] (Organic Filler)

The resin composition for cleaning a die of the invention preferably includes an organic filler as an additive in order to suitably maintain the strength of the resin composition for cleaning a die. Examples of the organic filler include pulps, wood powders, synthetic fibers, and the like. Of these, the pulps are particularly preferred.

[0036] Examples of the pulps include wood pulps (softwood pulps and hardwood pulps), non-wood pulps (straw, bamboo, bagasse, and cotton), and the like. For the pulps, both chemical and mechanical pulps can be used. The sizes of the pulps are not particularly limited, and are preferably from 5 to 1000 μm , more preferably from 10 to 200 μm . The size of the pulp in the range is preferred because of resulting in the favorable fluidity of the resin composition for cleaning a die. The size of the pulp in the range is preferred because of resulting in favorable operability in peeling from a die after cleaning since the strength of the resin composition for cleaning a die is maintained suitable in molding.

[0037] A content of the organic filler in the invention is preferably from 3 to 20 parts by mass with respect to 100 parts by mass of the total solid content of the resin composition for cleaning a die. The content of the organic filler in the range is preferred because of resulting in the appropriate fluidity of the resin composition for cleaning a die. The content of the organic filler in the range is preferred because of resulting in favorable operability in peeling from a die after cleaning since the strength of the resin composition for cleaning a die is maintained suitable in molding.

[0038] (Metal Salt of Saturated Fatty Acid)

The resin composition for cleaning a die of the invention preferably includes, as an additive, a metal salt of a saturated fatty acid, including a saturated fatty acid having from 12 to 20 carbon atoms and a metal selected from calcium, zinc, or magnesium, and more preferably includes a metal salt of a saturated fatty acid, including a saturated fatty acid having from 14 to 18 carbon atoms and a metal selected from calcium, zinc, or magnesium, in order to allow die releasing of a molded product from the inner surface of a molding die after cleaning to be favorable and to improve operability in peeling of the molded product from the die.

Examples of the saturated fatty acid having from 12 to 20 carbon atoms include

lauric acid having 12 carbon atoms (IUPAC name: dodecanoic acid), myristic acid having 14 carbon atoms (IUPAC name: tetradecanoic acid), palmitic acid having 16 carbon atoms (IUPAC name: hexadecanoic acid), stearic acid having 18 carbon atoms (IUPAC name: octadecanoic acid), arachidic acid having 20 carbon atoms (IUPAC name: eicosanoic acid), and the like.

In the invention, at least one of zinc myristate including a saturated fatty acid having 14 carbon atoms and zinc, zinc stearate including a saturated fatty acid having 18 carbon atoms and zinc, or calcium stearate including a saturated fatty acid having 18 carbon atoms and calcium is still more preferably included, and zinc myristate is particularly preferably included. Zinc myristate is preferred because of having a melting point of about from 123 to 130°C, of having sufficient fluidity at a temperature of from 160 to 190°C in die cleaning, and of easily acting on a stain.

[0039] A content of the metal salt of the saturated fatty acid in the invention is preferably from 0.1 to 5 parts by mass, more preferably from 0.3 to 3 parts by mass, with respect to 100 parts by mass of the total solid content of the resin composition for cleaning a die. The content of the saturated fatty acid in the range allows die releasing of a molded product from the inner surface of a molding die after cleaning to be favorable, results in improved operability in peeling of the molded product from the die, and allows performance for cleaning the inner surface of the molding die to be favorable.

[0040] (Other Components)

Unless deteriorating the effects of the invention, the resin composition for cleaning a die of the invention may further include a resin, such as an alkyd resin, a polyester resin, an acrylic resin, or an epoxy resin, or a rubber, if necessary. A known additive, for example, an additive such as a curing catalyst, a lubricant, a coloring agent, or an antioxidant may also be included.

[0041] Examples of the curing catalyst include organic acids such as phthalic anhydride, sulfamic acid, para-toluenesulfonic acid, benzoic acid, myristic acid, stearic acid, and oxalic acid; inorganic acids such as hydrochloric acid and sulfuric acid; and the like.

[0042] Examples of the lubricant include fatty acid amide-type lubricants, specifically, saturated and unsaturated monoamide-type lubricants such as lauric acid amide, myristic acid amide, erucic acid amide, oleic acid amide, and stearic acid amide; saturated and unsaturated bis amide-type lubricants such as methylenebis stearic acid amide, ethylenebis stearic acid amide, and ethylenebis oleic acid amide; and the like.

[0043] [Method of Preparing Resin Composition for Cleaning Die]

The resin composition for cleaning a die of the invention is prepared by substantially

homogeneously mixing, for example, the melamine-based resin, the inorganic filler, and another component such as the organic filler, the metal salt of the saturated fatty acid, or the additive, if necessary, using a kneader, a ribbon blender, a Henschel mixer, a ball mill, a roll mill, a grinding machine, a tumbler, or the like.

[0044] [Method of Using Resin Composition for Cleaning Die]

The resin composition for cleaning a die of the invention is preferable as a so-called transfer-type resin composition for cleaning a die, with which the inner surface of a molding die is cleaned by transfer molding.

Usually, the resin composition for cleaning a die of the invention, which is processed in tablet form, is used in an operation for cleaning the inner surface of a molding die. Specifically, a lead frame is placed on the molding die, and the resin composition for cleaning a die in tablet form is then inserted into a pot portion, mold-clamped, and then swept away by a plunger. In this case, the resin composition for cleaning a die in the pot portion is passed through a gate portion via a runner portion, and flows into a cavity. After a lapse of predetermined molding time, the die is opened, and a molded product united with the lead frame, i.e., the molded product of the resin composition for cleaning a die including a stain is removed.

[0045] The resin composition for cleaning a die of the invention removes a stain on the inner surface of a molding die, generated in the case of an operation for sealing molding of an integrated circuit or the like, by such a method as described above. The material of the molding die is for example, iron, chromium, or the like, and the inner surface of the molding die is usually plating-treated. A flaw having a micron size and abrasion are generated at the inner surface of the molding die by repeating a sealing molding operation and a cleaning operation. As a result, the plating-treated inner surface of the molding die is chipped, or a surface state is roughened. The chipping or roughening of the plating-treated surface results in deterioration of moldability and releasability and poor surface appearance in the sealing molding operation, and further in deterioration of operability for cleaning the inner surface of the molding die.

The resin composition for cleaning a die of the invention enables to suppress flaws and abrasion to be generated at the inner surface of a molding die, or the like since the average particle diameter, standard deviation of particle diameter, average aspect ratio of particle diameter, and standard deviation of aspect ratio of particle diameter of the inorganic filler which is a component are in the specific ranges.

[0046] Preferred embodiments of the resin composition for cleaning a die of the invention are described below.

<1> A resin composition for cleaning a die, including at least a melamine-based resin and an inorganic filler having an average particle diameter of from 4 to 12 μm , a standard deviation of particle diameter of 10 μm or less, an average aspect ratio of particle diameter of from 1 to 1.3, and a standard deviation of aspect ratio of particle diameter of 0.5 or less.

<2> The resin composition for cleaning a die according to the <1>, further including a metal salt of a saturated fatty acid, including a saturated fatty acid having from 14 to 18 carbon atoms and a metal selected from calcium, zinc, or magnesium.

<3> The resin composition for cleaning a die according to the <1> or <2>, wherein the inorganic filler is at least one selected from silicon carbide, silicon oxide, titanium carbide, titanium oxide, boron carbide, boron oxide, aluminum oxide, magnesium oxide, or calcium oxide.

<4> The resin composition for cleaning a die according to the <3>, wherein the inorganic filler is at least one selected from silicon oxide or aluminum oxide.

<5> The resin composition for cleaning a die according to any one of the <1> to <4>, used in transfer molding.

EXAMPLES

[0047] The invention will be further specifically explained below with reference to examples, but is not limited to the following examples unless departing from the spirit thereof.

[0048] -Preparation of Resin Composition for Cleaning Die-

[Preparation of Melamine-Phenol Co-condensate]

(Production Example 1)

After allowing 346 parts by mass of melamine, 131 parts by mass of phenol, 522 parts by mass of formaldehyde (37% aqueous solution), and 248 parts by mass of hardwood pulp (LDPR, manufactured by Nippon Paper Industries Co., Ltd.) as an organic filler to react by heating at from 80 to 90°C and under an alkali condition of a pH of from 7 to 7.5 for time before a 3 mass% aqueous solution of a reactant becomes cloudy at 60°C, the resultant was dried at reduced pressure, and powdered to obtain a melamine-phenol co-condensate containing an organic filler.

[0049] [Preparation of Resin Composition for Cleaning Die]

(Example 1)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, HS203, manufactured by Nippon Steel

Materials Co., Ltd. Micron Co.) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 1. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0050] (Example 2)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, HS205, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 2. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0051] (Example 3)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, SE-40, manufactured by Tokuyama Corporation) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 3. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope

(JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0052] (Example 4)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, SE-15, manufactured by Tokuyama Corporation) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 4. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0053] (Example 5)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of aluminum oxide (CB-P10, manufactured by Showa Denko K.K.) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 5. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0054] (Example 6)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of calcium carbonate (WHITON SB BLUE, manufactured by SHIRAISHI CALCIUM KAISHA, LTD.) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were

loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 6. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0055] (Example 7)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, HS203, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) as an inorganic filler, 0.5 part by mass of calcium stearate (CALCIUM STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 7. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0056] (Example 8)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, HS203, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) as an inorganic filler, 0.5 part by mass of zinc myristate (POWDER BASE M, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 8. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0057] (Example 9)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, HS203, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) as an inorganic filler, 0.5 part by mass of zinc laurate (ZS-3, manufactured by Nitto Chemical Industry Co., Ltd.) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 9. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0058] (Example 10)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, HS203, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) as an inorganic filler, 0.5 part by mass of zinc arachidate as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Example 10. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0059] (Example 11)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, HS203, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) as an inorganic filler, 0.5 part by mass of stearic acid (F-3, manufactured by Kawaken Fine Chemicals Co., Ltd.), and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die

cleaning of Example 11. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0060] (Comparative Example 1)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fractured silica, FS200, manufactured by DENKI KAGAKU KOGYO KABUSHIKI KAISHA) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Comparative Example 1. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was fractured.

[0061] (Comparative Example 2)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (fused silica, SO-C6, manufactured by Admatechs Company Limited) as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Comparative Example 2. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0062] (Comparative Example 3)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8

parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of mixture of silicon oxide (fused silica, HS203, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) and silicon oxide (fused silica, HS302, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) at a mass ratio of 1:1 as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Comparative Example 3. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was generally spherical.

[0063] (Comparative Example 4)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of mixture of silicon oxide (fused silica, TS10-141, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) and silicon oxide (fractured silica, F-CD10, manufactured by KINSEI MATEC CO., LTD.) at a mass ratio of 1:2 as an inorganic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Comparative Example 4. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler coexisted in generally spherical form and fractured form.

[0064] (Comparative Example 5)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of a mixture of silicon oxide (fused silica, HS203, manufactured by Nippon Steel Materials Co., Ltd. Micron Co.) and silicon oxide (fractured silica, F-CD10, manufactured by KINSEI MATEC CO., LTD.) at a mass ratio of 1:3 as an inorganic filler, 0.5

part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Comparative Example 5. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler coexisted in generally spherical form and fractured form.

[0065] (Comparative Example 6)

In a ball mill, 29.1 parts by mass of the melamine-phenol co-condensate containing the organic filler (including 21.3 parts by mass of melamine-phenol co-condensate and 7.8 parts by mass of organic filler), and 50 parts by mass of melamine resin, as a melamine-based resin, 20 parts by mass of silicon oxide (pure silica powder, manufactured by SETO CERAMIC RAW MATERIALS CO., LTD.) as an inorganic filler, 0.5 part by mass of zinc myristate (POWDER BASE M, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Comparative Example 6. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

In a case in which the inorganic filler was observed with an electron microscope (JSM-5510, manufactured by JEOL Ltd.), the inorganic filler was fractured.

[0066] (Comparative Example 7)

In a ball mill, 76.1 parts by mass of methylol melamine (NIKARESIN S-176, manufactured by NIPPON CARBIDE INDUSTRIES CO., INC.) as a melamine-based resin, 23 parts by mass of hardwood pulp (LDPR, manufactured by Nippon Paper Industries Co., Ltd.) as an organic filler, 0.5 part by mass of zinc stearate (ZINC STEARATE GF200, manufactured by NOF CORPORATION) as a metal salt of a saturated fatty acid, and 0.05 part by mass of benzoic acid as a curing catalyst were loaded, and ground. Then, 0.35 part by mass of stearic acid amide as a lubricant was added by a Nauta mixer to obtain a resin composition for cleaning a die cleaning of Comparative Example 7. The resin composition for cleaning a die obtained in such a manner was tablet-molded and used for a die cleaning evaluation.

[0067] -Measurement-

The average particle diameters, standard deviations of particle diameters, average aspect ratios of particle diameters, and standard deviations of aspect ratios of particle diameters of the inorganic fillers used in the resin compositions for cleaning dies of Examples 1 to 11 and Comparative Examples 1 to 7 were determined by methods described below. The measurement results are listed in Table 1 below.

[0068] An inorganic filler was photographed at a magnification of 1500 times using an electron microscope (JSM-5510, manufactured by JEOL Ltd.). The photographing was performed such that about 30 particles of the inorganic filler were included in one visual field, and each of the major diameters (X) and minor diameters (Y) of 150 particles of the inorganic filler in total included in different five visual fields was measured five times. The minor diameters (Y) were taken to be perpendicular to the major diameters (X). The average values of the five-time measured values of the major diameters (X) and the minor diameters (Y) were determined, and substituted into Expression 1 described below, and the particle diameter of one particle of the inorganic filler was calculated, followed by determining the average value of the particle diameters of the 150 particles of the inorganic filler and the standard deviation of the particle diameters of the 150 particles of the inorganic filler.

Particle diameter = ((average value of five-time measured values of X) + (average value of five-time measured values of Y)) / 2

Expression 1

[0069] The average values of the five-time measured values of the major diameters (X) and the minor diameters (Y) were substituted into Expression 2 described below, and the aspect ratio of the particle diameter of one particle of the inorganic filler was calculated, followed by determining the average value of the aspect ratios of the particle diameters of the 150 particles of the inorganic filler and the standard deviation of the aspect ratios of the particle diameters of the 150 particles of the inorganic filler.

Aspect ratio of particle diameter = (average value of five-time measured values of X) / (average value of five-time measured values of Y)

Expression 2

[0070] -Evaluation-

The cleaning performances and flawing properties of the resin compositions for cleaning dies of Examples 1 to 11 and Comparative Examples 1 to 7 were evaluated by methods described below. The evaluation results are listed in Table 1 below.

[0071] (1) Cleaning Performance

QFP (Quad Flat Package) was 400-shot molded by a transfer automatic molding machine (die temperature: 175°C, transfer pressure: 8.7 MPa, transfer time: 6.5 seconds, curing time: 90 seconds) using a commercially available epoxy resin molding material (EME-G700L, manufactured by Sumitomo Bakelite Co., Ltd.), to stain the inner surface of a

die.

Using the stained die, each of the resin compositions for cleaning dies prepared as described above was repeatedly molded under the same molding conditions as those described above. Then, the number of shots required for being able to completely remove the stains adhering to the inner surface of the die was measured, and was regarded as an index for evaluating the cleaning performance of each of the resin compositions for cleaning dies. It was judged by visual observation whether or not the stains were able to be completely removed.

For the evaluation, attention was paid particularly to whether the stains adhering to gate and corner portions in the cavities of the die were able to be removed. The gate portion of the die used in the evaluation had a width of 800 μm and a height of 300 μm .

The smaller number of shots exhibits superior cleaning performance.

[0072] (2) Flawing Properties

For evaluating the flawing properties of the resin compositions for cleaning dies, a commercially available Taber abrasion tester (MODEL 5155, manufactured by TABER INDUSTRIES) was used.

A test piece (100 mm $\times$ 100 mm, thickness: 7 mm) in which an SUS plate (material: ASP-23H) was subjected to hard chrome plating treatment was prepared. In a case in which the surface roughness of the test piece (R_a : arithmetic average roughness, according to JIS B 0601-2001) was measured using a laser microscope (VK-9710, manufactured by Keyence Corporation), the surface roughness was 0.099 μm .

The resin compositions for cleaning dies were molded as evaluation samples using a die having a shape having a width of 10 mm, a length of 100 mm, and a thickness of 4 mm. For an apparatus, a transfer automatic molding machine (die temperature: 170°C, transfer pressure: 6.9 MPa, transfer time: 30 seconds, curing time: 90 seconds) was used.

For advance preparations, a #1500 sandpaper was put on the rotating table of the Taber abrasion tester, each of the evaluation samples of the resin compositions for cleaning dies was fixed thereon using a tester jig such that a plane of 10 mm $\times$ 4mm was faced downward, and the rotating table was rotated 30 times at a rate of 60 rpm to expose the planar surface of the evaluation sample.

An abrasion test, in which the test piece was put on the rotating table of the Taber abrasion tester, the evaluation sample of which the planar surface was exposed was fixed thereon by the tester jig, and the rotating table was rotated 30 times at a rate of 60 rpm while applying a load of 1000 g, was conducted.

After the abrasion test, the surface roughness of the surface of the test piece (R_a :

arithmetic average roughness, according to JIS B 0601-2001) was measured using a laser microscope (VK-9710, manufactured by Keyence Corporation), and the value of the surface roughness was regarded as an index for evaluating the flawing properties of the resin compositions for cleaning dies.

The lower value of the surface roughness of the surface of the test piece exhibits a lower flawing level due to the evaluation sample. Accordingly, the lower value of the surface roughness of the surface of the test piece exhibits the resin composition for cleaning a die, with which abrasion and flaws are more suppressed at the inner surface and gate portions of a molding die.

[0073] [Table 1]

	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	C.Ex.	C.Ex.	C.Ex.	C.Ex.	C.Ex.	C.Ex.
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7				
Composition (part(s) by mass)	Melamine-based resin composition	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	76.1
	Silicon oxide	20	20	20	-	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-
	Aluminum oxide	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Calcium carbonate	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Organic filler	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	23
	Zinc stearate	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Calcium stearate	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Zinc myristate	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
	Zinc laurate	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Zinc arachidate	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Physical properties of inorganic filler	Stearic acid	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-
	Curing catalyst	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	Lubricant	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
	Average particle diameter (unit: μm)	7.9	4.5	11.5	10.0	8.5	5.2	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	-
	Standard deviation of the particle diameter (unit: μm)	6.74	3.64	8.98	9.80	7.12	5.01	6.74	6.74	6.74	6.74	6.74	6.74	6.74	6.74	6.74	6.74	6.74	6.74	6.74	6.74	-
	Average aspect ratio of particle diameter	1.20	1.04	1.25	1.23	1.13	1.10	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	-
	Standard deviation of aspect ratio of particle diameter	0.29	0.24	0.43	0.38	0.27	0.28	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	-
	Cleaning performance (the number of shots before being able to completely remove stains)	3	4	4	3	3	4*	3	4*	4*	4*	4*	4*	4*	4*	4*	4*	4*	4*	4*	4*	7
	Flawing properties (surface roughness Ra of test piece surface) (unit: μm)	0.102	0.101	0.112	0.116	0.115	0.101	0.104	0.102	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.099

In Table 1, the abbreviation "Ex." denotes "Example Number", and the abbreviation "C. Ex." denotes "Comparative Example Number". *) The number of shots before being able to completely remove a stain was the same as that of Example 2 or 3. However, for the state of a stain remaining on the die after finishing the third shot, a large amount of stain obviously remained in each of Examples 6 and 9 to 11 whereas a stain was able to be substantially removed in Examples 2 or 3.

[0074] As listed in Table 1, it was found that the resin composition for cleaning a die of the invention enables sufficient cleaning even in corner portions in the cavities of a molding die and suppresses abrasion and flaws at the inner surface of the molding die.

[0075] The relationships between the particle diameters and frequencies of the inorganic fillers used in the resin compositions for cleaning dies of Example 8 and Comparative Example 6 are indicated in Figure 1. The inorganic filler used in the resin composition for cleaning a die of Example 8 included 7% (11 of 150) particles having particle diameters of 2.5 μm or less.

[0076] The relationships between the aspect ratios of particle diameters and frequencies of the inorganic fillers used in the resin compositions for cleaning dies of Example 8 and Comparative Example 6 are indicated in Figure 2. The inorganic filler used in the resin composition for cleaning a die of Example 8 included 49% (74 of 150) particles having aspect ratios of particle diameters in a range of from 1.0 to 1.1.

[0077] The relationships between the approximate values of volumes and frequencies of the inorganic fillers used in the resin composition for cleaning a die of Example 8 and Comparative Example 6 are indicated in Figure 3. The volume of each of the inorganic fillers was determined by approximation of substituting the average value of the major diameters (X) and the minor diameters (Y), regarded as a particle diameter, into Expression 3 described below.

$$\text{Approximate value of volume} = 4 \times 3.14 \times (\text{particle diameter})^3 / 3 \quad \text{Expression 3}$$

The inorganic filler used in the resin composition for cleaning a die of Example 8 included 12% (18 of 150) particles having approximate values of volumes in a range of from 10 to 100 μm^3 .

[0078] As described in Examples and Comparative Examples above, the selection of at least a melamine-based resin composition and an inorganic filler as components and the control of the average particle diameter, standard deviation of particle diameter, average aspect ratio of particle diameter, and standard deviation of aspect ratio of particle diameter of the inorganic filler in specific ranges made it possible to realize the provision of the resin composition for cleaning a die, with which every nook and cranny of the cavities of a molding die can be

sufficiently cleaned, and abrasion and flaws are suppressed at the inner surface and gate portions of the molding die.

[Industrial Applicability]

[0079] The resin composition for cleaning a die of the invention is a transfer-type resin composition for cleaning a die, which is used for removing a stain, originating from a thermosetting resin composition, on a die surface, and with which every nook and cranny of the cavities of a molding die can be sufficiently cleaned, and the inner surface and gate portions of the molding die are inhibited from being abraded and flawed.

[0080] The disclosure of Japanese Application No. 2011-156953 is incorporated herein by reference in its entirety.

All the literature, patent applications, and technical standards described herein are herein incorporated by reference to the same extent as if each individual literature, patent application, or technical standard was specifically and individually indicated as being incorporated by reference.

WHAT IS CLAIMED IS

1. A resin composition for cleaning a die, comprising at least a melamine-based resin and an inorganic filler having an average particle diameter of from 4 to 12 μm , a standard deviation of particle diameter of 10 μm or less, an average aspect ratio of particle diameter of from 1 to 1.3, and a standard deviation of aspect ratio of particle diameter of 0.5 or less.
2. The resin composition for cleaning a die according to claim 1, further comprising a metal salt of a saturated fatty acid, the saturated fatty acid having from 14 to 18 carbon atoms and the metal being selected from the group consisting of calcium, zinc, and magnesium.
3. The resin composition for cleaning a die according to claim 1 or claim 2, wherein the inorganic filler is at least one selected from the group consisting of silicon carbide, silicon oxide, titanium carbide, titanium oxide, boron carbide, boron oxide, aluminum oxide, magnesium oxide, and calcium oxide.
4. The resin composition for cleaning a die according to claim 3, wherein the inorganic filler is at least one selected from the group consisting of silicon oxide and aluminum oxide.
5. The resin composition for cleaning a die according to any one of claims 1 to 4, being used in transfer molding.