

MOLD CLEANING COMPOSITION

FIELD OF THE INVENTION

The present invention relates to a mold cleaning
5 composition, which is a mold cleaning material to be used
for cleaning, renewing, and the like of molds such as molds
for thermoplastic resin composition molding material that
have been contaminated by repetitive molding work,
particularly, the mold cleaning material being used for
10 mold cleaning, renewing, and the like of molds for transfer
molding which is used in molding work for molding
semiconductor elements by the transfer molding with the use
of an epoxy resin molding material.

15 BACKGROUND OF THE INVENTION

As a conventional mold cleaning method, a method of
performing a mold cleaning work by detaching a mold from a
molding apparatus, such as a sand blast method, dry ice
blast method, a water jet method, and a strong alkali
20 cleaning method, has been known. However, in the case of
performing the mold cleaning work by detaching the mold
from the molding apparatus, a long work time is required
and a large amount of labor is required for the work.
Therefore, a method of performing a cleaning work with a
25 mold being mounted on a molding apparatus has been employed
more frequently, and a cleaning method using a melamine

resin, a cleaning method with ultraviolet ray irradiation, a cleaning method using a sheet-like cleaning composition, and the like have been carried out as such cleaning method.

Among all, a mold cleaning method of removing contaminants
5 from a mold by heat curing a sheet-like cleaning composition placed in the mold and removing the cured sheet-like cleaning composition to transfer the contaminants onto the cured sheet-like cleaning composition has been carried out since this method is excellent in work
10 efficiency.

As such sheet-like cleaning composition, for example, a mold cleaning composition using an unvulcanized rubber may be mentioned (see Patent Document 1). Also, a mold cleaning material in which a sheet-like base material is
15 coated with a compound that can be molded for cleaning may be mentioned (see Patent Document 2).

Patent Document 1: JP-A-9-262843.

Patent Document 2: JP-T-63-502497

20

SUMMARY OF THE INVENTION

However, the mold cleaning method of using the sheet-like cleaning composition and transferring contaminants onto the sheet-like cleaning composition for removing the
25 contaminants has a problem that air is contained in a cavity during molding depending on a shape or a size of the

cavity of the mold, and the air accumulated at a corner of the cavity causes a state where the sheet-like cleaning composition is not filled in the corner, resulting in insufficient removal of contaminants. For example, with
5 the mold cleaning composition disclosed in JP-A-9-262843, it is necessary to leave a gap (clearance) of about 1 to 1.5 mm by slightly opening upper and lower molds during clamping in order to prevent a rubber sheet to be cut off in the course of removing the rubber sheet after heat
10 vulcanization in the mold and to prevent the rubber sheet from remaining in the mold. However, in a cavity having a mold cavity of small size and large depth, air is entrapped at a cavity corner to result in forming a non-filled part. As a result, a problem of insufficient removal of
15 contaminants at the non-filled part is raised. Likewise, with the mold cleaning material disclosed in JP-T-63-502497, since a whole surface of a cavity is covered, entrapped air is not allowed to escape from the cavity to form a non-filled part, resulting in a problem of
20 insufficient removal of contaminants at the non-filled part.

Accordingly, since it is not suitable to use the sheet-like cleaning composition in the molds subject to the above-described troubles, the cleaning methods other than
25 the method of using the sheet-like cleaning composition have been employed for such molds. However, the other

cleaning methods require a long time as described above,
and the large amount of labor is actually burdensome.

The invention has been accomplished in view of the
above-described circumstances, and an object thereof is to
5 provide a mold cleaning composition having an excellent
mold filling property and achieving an excellent effect of
cleaning contaminants in a mold.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Fig. 1 is a perspective view showing a sheet-like mold
cleaning composition according to one embodiment of the
invention.

Fig. 2 is an illustration of a state in which slits
are formed on the sheet-like mold cleaning composition.

15 Fig. 3 is an enlarged side view showing a part of the
slits.

Fig. 4 is a perspective view showing a state of using
the sheet-like mold cleaning composition.

20 Fig. 5 is a perspective view showing a state of using
the sheet-like mold cleaning composition.

Fig. 6 is a perspective view showing a state of using
the sheet-like mold cleaning composition.

25 Fig. 7 is an illustration of an effect of the sheet-
like mold cleaning composition for molding semiconductor
device.

Fig. 8 is an illustration of an effect of the sheet-like mold cleaning composition for molding semiconductor device.

5 Description of Reference Numerals and Signs

10: sheet

11: slit

DETAILED DESCRIPTION OF THE INVENTION

10 In order to attain the above object, a mold cleaning composition of the invention is a cleaning composition to be used for molds used for heat molding repeatedly for molding a molding material, which contains as essential components an unvulcanized rubber, a cleaning agent, and a
15 vulcanizing agent, in which a weight average molecular weight (Mw) of the cleaning composition as a whole is set to a range of from 200,000 to 460,000 according to the measurement by gel permeation chromatography (GPC).

The inventors of the invention have conducted an
20 extensive research to obtain a cleaning composition capable of being satisfactorily filled in every part of a mold cavity by preventing formation of a non-filled part otherwise caused by air entrapment occurring during mold cleaning work using a mold cleaning composition, as well as
25 of effectively removing contaminants in the mold cavity. The inventors have focused attention on the filling

property to the mold cavity and conducted a series of studies mainly on fluidity of a cleaning composition capable of minimizing the air entrapment in the course of filling the cleaning composition in the mold cavity. More specifically, in order to enhance the filling property to the mold cavity, it is necessary to achieve a flowing state that enables the minimization of the air entrapment in the course of filling the cleaning composition as well as to reduce a mold clearance during molding (clamping) for increasing an inner pressure of the mold cavity. Particularly, from the view point of a property of fitting to the mold cavity, a viscosity of the cleaning composition may preferably be low, but the inner pressure of the mold cavity during molding is reduced when the viscosity is too low to fail to crush the entrapped air, resulting in formation of the non-filling part. On the other hand, when the viscosity of the cleaning composition is too high, the fitting property to the mold cavity is deteriorated to cause the non-filling part to be formed easily. The inventor has conducted further studies based on the above findings to obtain a cleaning composition having an appropriate viscosity and found that the cleaning composition having the weight average molecular weight (Mw) in the above-specified range according to the measurement by gel permeation chromatography (GPC) enables the

appropriate viscosity and a good filling property, thereby accomplishing the invention.

Namely, the present invention relates to the followings.

5 (1) A mold cleaning composition comprising an unvulcanized rubber, a cleaning agent, and a vulcanizing agent, wherein said cleaning composition as a whole has a weight average molecular weight (Mw) within a range of from 200,000 to 460,000 according to the measurement by gel
10 permeation chromatography (GPC).

 (2) The mold cleaning composition according to (1), wherein said cleaning composition as a whole has a weight average molecular weight (Mw) within a range of from 220,000 to 430,000 according to the measurement by gel
15 permeation chromatography (GPC).

 (3) The mold cleaning composition according to (1) or (2), which has a sheet-like shape or a strip shape.

 (4) The mold cleaning composition according to any one of (1) to (3), wherein the cleaning agent is at least
20 one member selected from the group consisting of glycolether, imidazole, imidazoline, and aminoalcohol.

 (5) The mold cleaning composition according to any one of (1) to (4), wherein the cleaning agent is contained in an amount of from 10 to 60 parts by weight with respect
25 to 100 parts by weight of the unvulcanized rubber.

(6) The mold cleaning composition according to any one of (1) to (5), which further comprises water in an amount of from 1 to 20 wt%.

(7) The mold cleaning composition according to any
5 one of (1) to (6), which further comprises a release agent.

(8) The mold cleaning composition according to any one of (1) to (7), wherein the mold cleaning composition has a sheet-like shape in which a plurality of linear slits are disposed on a sheet surface thereof in one direction at
10 a predetermined interval and in parallel with each other.

(9) The mold cleaning composition according to (8), wherein said slits are disposed so that said sheet-like mold cleaning composition is capable of being folded.

(10) The mold cleaning composition according to (8),
15 wherein said slits are disposed so that said sheet-like mold cleaning composition is capable of being cut along said slits.

(11) The mold cleaning composition according to any one of (1) to (10), which is a cleaning composition to be
20 used for a mold used for heat molding repeatedly for molding a molding material.

As described above, the mold cleaning composition of the invention contains an unvulcanized rubber, a cleaning agent, and a vulcanizing agent as essential components and
25 has a weight average molecular weight (Mw) as a whole in the specified range according to a measurement by gel

permeation chromatography (GPC). Accordingly, the cleaning composition has an appropriate viscosity and achieves an excellent property of being filled into molds. Therefore, when a mold surface is cleaned by using the mold cleaning composition of the invention, the mold cavity is filled uniformly with the mold cleaning composition to cause contaminants on the mold surface to adhere to the mold cleaning composition, thereby effectively removing the contaminants integrally with the mold cleaning composition from the mold. For example, contaminants on a surface of a mold for transfer molding for molding semiconductor elements, which has been used repeatedly for molding using an epoxy resin composition, are combined into a molded article made from the mold cleaning composition to be removed effectively from the mold, whereby the cleaning of the mold can be effectively conducted. Therefore, a semiconductor device formed by using the mold which is cleaned with the mold cleaning composition of the invention has an excellent appearance.

20 In the case that the mold cleaning composition has a sheet-like shape or a strip shape, it is possible to easily position such mold cleaning composition for cleaning a mold cavity.

Further, it is possible to obtain an excellent mold cleaning effect by using glycolethers, imidazoles, imidazolines, or aminoalcohols as the cleaning agent.

It is possible to achieve a further excellent cleaning property when the mold cleaning composition contains water in an amount of from 1 to 20 wt%.

When the mold cleaning composition is molded so as to
5 have a sheet-like shape and is provided with a plurality of linear slits disposed in one direction on a sheet surface thereof, it is possible to stack the sheet easily by folding the sheet along the slits. In this case, since respective block pieces sectioned by the parallel slits are
10 connected with each other at the parts under the slits, the sheet can be stacked tidily without displacement during folding, and the respective block pieces are not intersected or the like in stacking. Therefore, the obtained stack is not in an irregular shape. By cleaning a
15 mold by using the tidily stacked sheet-like cleaning composition, it is possible to eliminate cleaning failure otherwise caused by insufficient pressure contact between an unvulcanized rubber and a surface of the mold, for example. Further, since it is unnecessary to measure a
20 size of the sheet for cutting the sheet in pieces having an identical size, and since it is unnecessary to perform a complicated work of aligning the cut sheet pieces for stacking, it is possible to simplify the cleaning work.

Furthermore, when the mold cleaning composition has a
25 sheet-like shape and, particularly, is provided with a plurality of linear slits disposed in one direction on a

sheet surface thereof so as to enable the sheet-like mold cleaning composition to be cut along the slits, it is possible to cut the sheet easily to fit a smaller mold size without irregularity.

5 Hereinafter, embodiments of the invention will be described.

 The mold cleaning composition of the invention has a specific weight average molecular weight as a whole and is obtainable by using an unvulcanized rubber which serves as
10 a base material, a cleaning agent, and a vulcanizing agent as essential components.

 Examples of a rubber material used as the unvulcanized rubber include, but not particularly limited to, conventional rubbers such as a butadiene rubber (BR), an
15 ethylene-propylene-diene rubber (EPDM), an ethylene-propylene rubber (EPM), and a styrene-butadiene rubber (SBR). These may be used alone or in combination of two or more thereof. Each of these unvulcanized rubbers is vulcanized in a mold to be a vulcanized rubber.

20 Among these, EPM, EPDM, BR, or a mixture thereof may preferably be used as the unvulcanized rubber since these rubbers are less contaminating when they are vulcanized in molding using a mold and are less malodorous during the vulcanization.

25 More specifically, EPDM is a terpolymer containing ethylene, α -olefin (particularly propylene), and a polyene

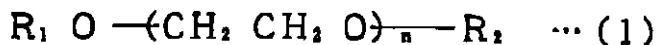
monomer listed below, and examples of the polyene monomer include dicyclopentadiene, 1,5-cyclooctadiene, 1,1-cyclooctadiene, 1,6-cyclododecadiene, 1,7-cyclododecadiene, 1,5,9-cyclododecatriene, 1,4-cycloheptadiene, 1,4-cyclohexadiene, norbornadiene, methylenenorbornene, 2-methylpentadiene-1,4, 1,5-hexadiene, 1,6-heptadiene, methyl-tetrahydroindene, and 1,4-hexadiene.

A copolymerization proportion of each of the monomers in the EPDM may be such that ethylene is 30 to 80 mol%, the polyene monomer is 0.1 to 20 mol%, and the rest is α -olefin in the terpolymer. More preferably, ethylene is 30 to 60 mol%. It is preferable to use EPDM having a weight average molecular weight (Mw) of 100,000 to 300,000, more preferably 150,000 to 250,000.

As the butadiene rubber (BR), 1,2-polybutadiene, 1,4-polybutadiene, or a mixture thereof may be used. A Mooney viscosity ML_{1+4} (100°C) of the butadiene rubber may be 20 to 80, more preferably 35 to 60. It is preferable to use the butadiene rubber having a weight average molecular weight (Mw) of 200,000 to 600,000, more preferably 400,000 to 600,000.

Examples of the cleaning agent include glycolethers, imidazoles, imidazolines, and aminoalcohols. These may be used alone or in combination of two or more thereof.

The above-mentioned glycolethers are compounds represented by the following formula (1).



5

(In the formula (1), n is a positive integer, and each of R₁ and R₂ is hydrogen or an alkyl group. When one of R₁ and R₂ is hydrogen, the other is the alkyl group. When both of R₁ and R₂ are alkyl groups, R₁ and R₂ may be the same or
10 different.)

Examples of glycolethers represented by the formula

(1) include ethyleneglycoldimethylether,

diethyleneglycoldimethylether,

triethyleneglycoldimethylether,

15 tetraethyleneglycoldimethylether,

polyethyleneglycoldimethylether,

diethyleneglycolmonopropylether,

diethyleneglycolmonobutylether,

diethyleneglycoldiethylether,

20 ethyleneglycolmonomethylether,

ethyleneglycolmonoethylether,

ethyleneglycolmonopropylether, and

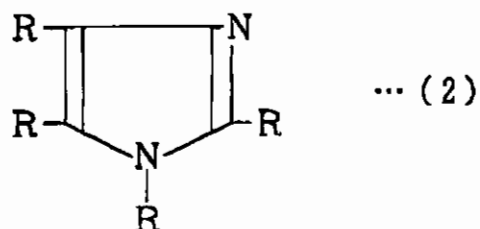
ethyleneglycolmonobutylether. These may be used alone or in combination of two or more thereof.

25 Among the above glycolethers represented by the formula (1), it is preferable to use those in which a

repetition number n is 1 to 2 and one of R_1 and R_2 is an alkyl group having 1 to 4 carbon atoms when the other is hydrogen; or those in which a repetition number n is 1 to 2 and R_1 and R_2 are alkyl groups each having 1 to 4 carbon atoms when both of R_1 and R_2 are alkyl groups. Herein, compatibility with the rubber is deteriorated in the case that the repetition number n is 3 or larger. Further, in the case that the number of carbon atoms of the alkyl group is 5 or more, permeability to an oxidized degraded layer of a release agent or the like is deteriorated. A boiling point of the glycolethers may preferably be about 130°C to 250°C. More specifically, since mold molding is usually performed at 150°C to 185°C, evaporation during cleaning is remarkably fast to cause cleaning work environment to be deteriorated in some cases when the boiling point of the glycolethers is less than 130°C. When the boiling point exceeds 250°C, the evaporation becomes difficult to cause the glycolether to remain in the vulcanized rubber, whereby the vulcanized rubber after cleaning is reduced in strength and the vulcanized rubber may be broken or the like upon taking out the cleaning composition from the mold. Accordingly, it becomes difficult to satisfactorily peel off the oxidized degraded layer or the like of the release agent from a surface of the mold, resulting in tendency of deteriorating the cleaning work efficiency.

Each of the glycolethers may be used as it is or mixed with water, an alcohol such as methanol, ethanol, and n-propanol, or an organic solvent such as toluene and xylene in use. In the case of mixing the glycolether with an organic solvent, an amount of the organic solvent may preferably be set to 50 parts by weight or less, more preferably to 20 parts by weight or less, with respect to 100 parts by weight of glycolether.

Favorable effects can be achieved by using imidazole represented by the following formula (2) as the above-mentioned imidazoles.



15

(In the formula (2), each of R's is H, a linear hydrocarbon group having a substitution group and having 10 or less carbon atoms, a linear hydrocarbon group having no substitution group and having 10 or less carbon atoms, or an aromatic group, and R's may be the same or different.)

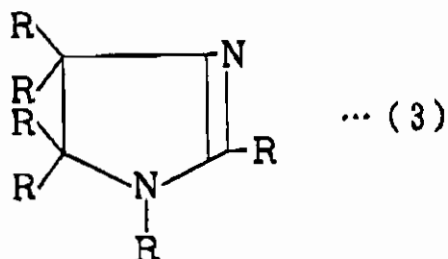
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Examples of such imidazole include 2-methylimidazole, 2-ethyl-4-methylimidazole, 2-phenylimidazole, 1-benzyl-2-methylimidazole, and 2,4-diamino-6[2'-methylimidazolyl-(1)']ethyl-s-triadine. These may be used alone or in combination of two or more thereof.

25

Favorable effects can be achieved by using imidazoline represented by the following formula (3) as the above-mentioned imidazolines.

5



(In the formula (3), each of R's is H, a linear hydrocarbon group having a substitution group and having 10 or less carbon atoms, a linear hydrocarbon group having no substitution group and having 10 or less carbon atoms, or an aromatic group, and R's may be the same or different.)

Examples of the imidazoline include 2-

15 methylimidazoline, 2-methyl-4-ethylimidazoline, 2-phenylimidazoline, 1-benzyl-2-methylimidazoline, 2-phenyl-4-methyl-5-hydroxymethylimidazoline, 2,4-diamino-6[2'-methylimidazoliny-(1)']ethyl-s-triadine, 2,4-diamino-6[2'-methyl-4'-imidazoliny-(1)']ethyl-s-triadine, 1-cyanoethyl-20 2-methylimidazoline, and 1-cyanoethyl-2-methyl-4-ethylimidazoline. These may be used alone or in combination of two or more thereof.

As in the case of the glycolethers, each of the imidazoles and the imidazolines may be used as it is or may 25 be mixed with an alcohol such as methanol, ethanol, and n-propanol, and an organic solvent such as toluene and xylene

in use. In the case of mixing the imidazole with an alcohol or an organic solvent, an amount of the alcohol or the organic solvent may preferably be set to 50 parts by weight or less, more preferably to 20 parts by weight or less, with respect to 100 parts by weight of at least one of the imidazoles and the imidazolines.

As the above-mentioned aminoalcohols, the following aminoalcohols may be used for achieving favorable effects.

Representative examples of the aminoalcohol include monoethanolamine, diethanolamine, triethanolamine, N-methylethanolamine, N,N-dimethylethanolamine, N,N-dibutylethanolamine, N,N-diethylethanolamine, N-methyl-N,N-diethanolamine, 2-amino-2-methylpropanol, 3-aminopropanol, and 2-aminopropanol. These may be used alone or in combination of two or more thereof.

The aminoalcohol may be used as it is or may be mixed with an alcohol such as methanol, ethanol, and n-propanol and an organic solvent such as toluene and xylene in use, as in the case of the above-described other cleaning agents. In the case of mixing the alcohol amine with an alcohol and an organic solvent, an amount of the alcohol or the organic solvent may preferably be set to 50 parts by weight or less, more preferably to 20 parts by weight or less, with respect to 100 parts by weight of the aminoalcohol.

A content of the cleaning agent (glycolethers, imidazoles, imidazolines, or aminoalcohols) may preferably be set to a range of from 10 to 60 parts by weight, more preferably from 15 to 25 parts by weight, with respect to 100 parts by weight of the unvulcanized rubber. When the content of the cleaning agent is less than 10 parts by weight, it is difficult to exert a satisfactory cleaning effect on the mold. When the content thereof exceeds 60 parts by weight in the case of cleaning the mold by using the thus-obtained mold cleaning composition, the composition sticks to the mold, whereby work efficiency of peeling off the composition from the mold is deteriorated.

The vulcanizing agent is not particularly limited, and conventional vulcanizing agents may be employed. Examples of the vulcanizing agent include sulfur and an organic peroxide such as n-butyl-4,4-bis(t-butylperoxy)valerate and 1,1-di(t-butylperoxy)-3,3,5-trimethylcyclohexane. These may be used alone or in combination of two or more thereof. A content of the vulcanizing agent may preferably be set to a range of from 1 to 3 parts by weight with respect to 100 parts by weight of the unvulcanized rubber.

Further, the mold cleaning composition of the invention may optionally contain a release agent, a reinforcing agent, and the like, in addition to the

unvulcanized rubber, the cleaning agent, and the vulcanizing agent.

The release agent is not particularly limited, and conventional release agents may be employed. Examples of the release agent include long chain aliphatic acid such as stearic acid and behenic acid; a metal salt of long chain aliphatic acid represented by zinc stearate and calcium stearate; an ester-based wax represented by a carnauba wax, a montan wax, and a partially saponified ester of montanic acid; a long chain aliphatic amide represented by stearylethylenediamide; and paraffin represented by a polyethylene wax.

A content of the release agent may preferably be set to a range of from 1 to 10% by weight with respect to the total weight of the mold cleaning composition. When the content of the release agent is less than 1% by weight, it is difficult to exhibit sufficient release effect. When the content thereof exceeds 10% by weight, cleaning ability may be deteriorated and an appearance of a molded article manufactured by using a mold after recycling may be deteriorated.

Examples of the reinforcing agent include an inorganic reinforcing agent (filler) such as silica, alumina, carbon black, calcium carbonate, calcium silicate, aluminum hydroxide, titanium dioxide, and titanium oxide. A content of the reinforcing agent may preferably be set to

a range of from 10 to 50 parts by weight with respect to 100 parts by weight of the unvulcanized rubber.

Further, it is possible to add water to the unvulcanized rubber when the cleaning composition contains the unvulcanized rubber dough as a base material. A content of the water may preferably be set to a range of from 1 to 20% by weight with respect to the total weight of the mold cleaning composition.

The mold cleaning composition of this invention may be manufactured, for example, as described below. The unvulcanized rubber serving as the base material, the cleaning agent, the vulcanizing agent, and other additives are mixed, and the mixture is kneaded by a batch type kneader and then formed into a sheet-like shape or a strip shape by using an extruder or a roller, thereby obtaining the mold cleaning composition. In the case that the mold cleaning composition is used as a sheet, a thickness of the sheet is usually set to 3 to 10 mm.

It is necessary to adjust a weight average molecular weight (Mw) of the thus-obtained mold cleaning composition as a whole to 200,000 to 460,000, which is measured by gel permeation chromatography (GPC). Particularly preferred weight average molecular weight (Mw) thereof is 220,000 to 430,000. When Mw is less than 200,000, a viscosity of the mold cleaning composition is lowered, and a pressure escapes from a clearance of the mold during molding so that

the mold cleaning composition fails to spread every part of the mold due to the reduction in pressure inside a mold cavity, resulting in formation of a non-filled part. When Mw thereof exceeds 460,000, the viscosity of the mold cleaning composition is raised to reduce a fitting property of the mold cleaning composition to the mold cavity, resulting in formation of a non-filled part.

The GPC measurement is performed, for example, as described below. The obtained mold cleaning composition is soaked into chloroform to be left to stand for three days. Subsequently, a chloroform soluble part is heated on a hot plate to be dried and solidified. The obtained dried and solidified matter is adjusted by using a 0.1 wt% tetrahydrofuran (THF) solution to be left to stand for a day. Subsequently, the solution is filtrated by using a 0.45 μm membrane filter, and a GPC measurement of the filtrate is conducted under predetermined conditions by using a predetermined analyzer. In the GPC measurement, the solvent to be used is not limited to the THF solution and is selected appropriately depending on the components of the cleaning composition which is the measurement object.

The mold cleaning composition may preferably have a light color such as white and grayish color close to white. By adjusting the color, it is possible to confirm contaminants removed from a mold and adhered to the mold

cleaning composition easily by unaided eyes after the mold cleaning, thereby achieving an effect of making it possible to easily confirm a state of the mold cleaning.

In the case of using the mold cleaning composition of the invention, it is preferable to use the mold cleaning composition that is molded in the form of a sheet. In using the sheet-like mold cleaning composition, from the view points of easiness of mold cleaning work by using the sheet-like mold cleaning composition and the like, a sheet 10 of which a sheet surface is provided with a plurality of linear slits 11 disposed at a predetermined interval and in parallel to each other as shown in Fig. 1 to make the sheet 10 foldable is suitably used. More preferably, the sheet 10 has a sheet surface having a stripe pattern. By folding the sheet 10 by using the slits 11, it is possible to tidily stack the sheets 10.

The sheet 10 provided with the slits 11 may be manufactured as described below. The rolled sheet obtained as described above is cut into predetermined shape and size to obtain the sheets 10, and the slits 11 are formed on an upper surface of each of the sheets 10. The formation of the slits 11 is performed, for example as shown in Fig. 2, by using a ribbon slitter in which circular cutting blades 13 are attached to a rotation shaft 12, and moving the cutting blades 13 with the cutting blades 13 being buried into the sheet 10 by a predetermined depth from the upper

surface of the sheet 10 and in a widthwise direction of the sheet 10 to form the slits 11 that are in parallel to one another. By repeating the above operation, slits 11 that are disposed at the constant interval and in parallel to each other are formed on the whole part of the upper surface of the sheet 10. The sheet 10 is sectioned into block pieces 10a having an identical size by the slits 11. Since the slits 11 are formed at the constant interval, the slits 11 have a function of a scale when the sheet is folded, so that it is possible to cut or fold the sheet 10 in accordance with the size of the mold to be cleaned or the cavity.

Further, as shown in Fig. 3, a distance D between an end of each of the slits 11 and a sheet surface facing the end of the slits 11 may preferably be set to about 0.1 to 0.8 mm, more preferably about 0.2 to 0.5 mm. The block pieces 10a tend to be separated easily when the distance is less than 0.1 mm, and the folding is less smooth when the distance exceeds 0.8 mm.

A method of cleaning mold by using the mold cleaning composition of the invention formed into the sheet-like shape is performed on molds to be used for molding semiconductor devices. For example, the sheet which is in an unvulcanized state is placed in the mold and then heat vulcanized to cause contaminants to adhere to the sheet

integrally. Subsequently, cleaning of the mold is performed by removing the vulcanized sheet from the mold.

The mold cleaning method using the sheet-like mold cleaning composition will be described below in detail in the order of events.

To start with, the sheet-like mold cleaning composition of the invention is prepared. Then, the sheet-like mold cleaning composition 10 is placed between an upper mold 1 in which depressions 3a are formed and a lower mold 2 in which depressions 3b are formed as shown in Fig. 4, and the upper mold 1 and the lower mold 2 are clamped to sandwich the sheet-like mold cleaning composition 10 for pressure molding as shown in Fig. 5. The sheet 10 is filled into a cavity 3 which is formed of the depression 3a formed in the upper mold 1 and the depression 3b formed in the lower mold 2 and brought into a pressure contact with mold surfaces by the pressure for molding. In this state, the unvulcanized rubber is heat vulcanized by the heat for molding to be a vulcanized rubber, so that an oxidized degraded layer of a release agent and the like formed in the cavity 3 are combined with the vulcanized rubber. In some cases, burr around the cavity 3 is also combined with the vulcanized rubber. Subsequently, as shown in Fig. 6, the upper mold 1 and the lower mold 2 are opened after a predetermined time period to peel off the sheet-like mold cleaning composition 10 that has become the vulcanized

rubber from the upper and lower molds 1 and 2, thereby peeling off the oxidized degraded layer and the like combined with the sheet 10 from surfaces of the upper and lower molds 1 and 2. Thus, the mold cleaning is performed.

5 As the sheet-like mold cleaning composition, it is possible to use the sheet-like mold cleaning composition provided with a plurality of linear slits 11 that are formed on the sheet surface of the sheet in parallel to each other at a predetermined interval as shown in Fig. 1
10 for enabling the sheet 10 to be folded.

 In the case of using such sheet-like cleaning composition, as shown Fig. 7, a required number of the block pieces 10a are cut off from the sheet 10 along the slit 11. This cutting may be performed by picking the
15 sheet 10 with fingers and folding along the slit 11 repeatedly or by using a knife or the like. Then, as shown in Fig. 8, the sheet 10 is folded along the slit 11 with the upper surface of the sheet 10 (the surface on which the slits 11 are formed) being oriented outward (herein, 4
20 block pieces 10a are being cut off in Fig. 8), and the sheet 10 is continuously folded until the bottom surfaces thereof contact with each other to stack the block pieces 10a as shown in Fig. 8. The block pieces 10a are not detached from one another during the folding since the
25 block pieces 10a are connected with each other at bottom parts 11a of the slits 11. Thus, only by the simple

operation of folding, it is possible to tidily stack the block pieces 10a with the block pieces 10a being aligned along a lengthwise direction and a widthwise direction without the block pieces 10a being intersected with each other. Therefore, it is possible to eliminate the labor of measuring the size of the sheet 10 for cutting the sheet 10 into pieces having an identical size or aligning detached block pieces 10a.

Although the state in which the two block pieces 10a are stacked on the other two block pieces 10a by folding the four block pieces 10a that have been cut off from the sheet at the center of the four block pieces 10a is shown in Fig. 8, the invention is not limited thereto, and it is possible to cut off and fold an appropriate number of block pieces 10a to stack the block pieces 10a into an appropriate size (for example, three block pieces 10a are stacked on the other three block pieces 10a to use six block pieces 10a) in accordance with the size of a mold to be cleaned or a cavity.

One example of molds for which the mold cleaning composition of the invention is to be used is, for example, a mold for molding semiconductor devices with which repetitive molding is performed by using a thermosetting resin composition.

In the mold for molding semiconductor device, which is one example of molds for which the mold cleaning

composition of the invention is used, examples of the thermosetting resin composition to be used as a molding resin material include an epoxy resin composition containing an epoxy resin as a main component.

5 In the thermosetting resin composition, a curing agent is usually used together with the epoxy resin serving as the main ingredient.

 Since the mold cleaned with the mold cleaning composition of the invention is free from contaminants and
10 restored to a mold surface of an initial state, a release agent is usually coated on the mold surface before molding semiconductor packages using the thermosetting resin composition serving as the mold material. For example, in the case of molding a mold material containing a montanic
15 acid wax as the release agent, it is preferable to coat the montanic acid wax. As a method for coating the montanic acid wax on the mold surface, it is preferable to use an unvulcanized rubber composition containing a montanic acid wax and formed into a sheet-like shape, such as sheets
20 obtainable by mixing the unvulcanized rubber described in the foregoing and the release agent. The sheet formed by the unvulcanized rubber composition containing the montanic acid wax is placed and heated in a mold in the same manner as in the cleaning process using the sheet-like mold
25 cleaning composition, so that the montanic acid wax contained therein is coated on the mold surface. It is

considered that the montanic acid wax in the unvulcanized rubber composition is melted by the heat vulcanization and exuded out to the mold surface to form a uniform release agent film on the surface.

5 A content of the montanic acid wax may preferably be set to a ratio of from 15 to 35 parts by weight, more preferably 20 to 30 parts by weight, with respect to 100 parts by weight of the rubber material in the unvulcanized rubber composition. When the content of the montanic acid
10 wax is less than 15 parts by weight, sufficient release effect is not exhibited. When the content thereof exceeds 35 parts by weight, the montanic acid wax is coated on the mold surface in an excessive amount to cause deterioration in appearance of molded articles that are obtained by using
15 the mold after the cleaning and recycling.

Hereinafter, Examples and Comparative Examples will be described.

Examples 1 to 6, and Comparative Examples 1 to 5

20 Components in proportions shown in Tables 1 to 2 are mixed, and each of the mixtures was kneaded by a kneader and rolled by using a pressure roller to obtain a sheet having a thickness of 5 mm, thereby obtaining desired sheet-like mold cleaning compositions.

25 A weight average molecular weight (Mw) of each of the sheet-like mold cleaning compositions was measured as

described below. The sheet-like mold cleaning composition was soaked into chloroform and left to stand for three days. Subsequently, a chloroform solubilized fraction was heated on a hot plate at 50°C to be dried and solidified, and the obtained dried and solidified matter was adjusted by using a 0.1 wt% tetrahydrofuran (THF) solution to be left to stand for a day. Subsequently, the solution was filtrated by using a 0.45 µm membrane filter, and a measurement of a weight average molecular weight (Mw) of the filtrate was conducted by using a GPC analyzer (HLC-8120GPC, manufactured by Tosoh Corporation) under following measurement conditions.

Measurement Conditions

Column: GMH_{XL} + GMH_{XL} + G3000H_{XL}, manufactured by Tosoh Corporation

Column Size: each having diameter of 7.8 mm x 30 cm, total size; 90 cm

Column Temperature: 40°C

Eluting Solution: THF

Flow rate: 0.8 ml/min

Inlet Pressure: 2.3 MPa

Injected Amount: 100 µl

Detector: Differential Refractometer (RI)

Standard Sample: Polystyrene (PS)

Data Processing Apparatus: GPC-8020, manufactured by
Tosoh Corporation

A filling property of each of thus-obtained sheet-
5 like mold cleaning compositions of Examples, Comparative
Examples, and Conventional Examples was evaluated as
described below. By using molds for filling property
evaluation [mold size: 24 mm x 91 mm; mold cavity size: 4
mm x 5 mm x 2.0 mm (total depth of upper and lower
10 cavities)], a filling ratio of the cavity that was the
worst in filling property among 16 cavities was evaluated.
Results are shown in Tables 1 and 2.

The filling ratio was detected by calculating a
bottom surface area of the mold cavity and a bottom surface
15 area of a cavity part of an obtained molded article and
then calculating a ratio between the bottom surface areas.
As shown in Fig. 4, eight cavities 3 are aligned in each of
two rows that are parallel to each other in the mold formed
of the upper mold 1 and the lower mold 2. A gap between
20 the cavities 3 disposed in parallel to each other as
described above is 10 mm, and the eight cavities 3 aligned
in each of the rows are disposed at an interval of 1 mm.
The size of the sheet-like mold cleaning composition 10
used as the sample was set to a width of 10 mm, a length of
25 91 mm, and a thickness of 5 mm, and the sample was disposed
between the rows of the cavities 3 in the mold for

evaluation, followed by closing the mold for heat molding. As molding conditions, molding was performed at 175°C for 5 minutes, and a gap between the molds for clamping was 0.5 mm.

5

Table 1

	(parts)					
	Examples					
	1	2	3	4	5	6
EPDM *1	100	30	50	30	30	30
BR *2	-	70	50	70	70	70
White Carbon	40	40	40	40	40	40
Montanic Acid Wax	12	12	12	12	12	12
Imidazole *3	10	10	5	-	-	-
Imidazoline *4	-	-	-	5	-	-
Glycolether *5	-	-	-	-	10	-
Aminoalcohol *6	-	-	-	-	-	5
Organic Peroxide *7	2	2	2	2	2	2
Water	5	5	5	5	5	5
Weight Average Molecular Weight (Mw) of Mold Cleaning Composition	220,000	430,000	370,000	430,000	430,000	430,000
Cavity Filling Ratio (%)	100%	100%	100%	100%	100%	100%

*1: copolymerization ratio among ethylene (a), propylene (b), and ethylidenenorbornene (c) is 67/31/2 at molar

10 ratio; weight average molecular weight (Mw) is 220,000.

*2: 1,4-polybutadiene; Mooney viscosity ML_{1+4} (100°C) of 45 M; weight average molecular weight (Mw) of 490,000.

*3: 2,4-diamino-6[2'-methylimidazoliny1-(1)']ethyl-s-triadine.

5 *4: 2-methyl-4-ethylimidazoline.

*5: ethyleneglycolmonomethylether.

*6: 2-amino-2-methylpropanol.

*7: n-butyl-4,4-bis(t-butylperoxy)valelate.

10 Table 2

	(parts)				
	Comparative Examples				
	1	2	3	4	5
EPDM *1	100	-	100	100	100
BR *2	-	100	-	-	-
White Carbon	40	40	40	40	40
Montanic Acid Wax	12	12	12	12	12
Imidazole *3	10	10	-	-	-
Imidazoline *4	-	-	5	-	-
Glycolether *5	-	-	-	10	-
Aminoalcohol *6	-	-	-	-	5
Organic Peroxide *7	2	2	2	2	2
Water	5	5	5	5	5
Weight Average Molecular Weight (Mw) of Mold Cleaning Composition	180,000	490,000	180,000	180,000	180,000
Cavity Filling Ratio (%)	80%	90%	75%	70%	75%

- *1: copolymerization ratio among ethylene (a), propylene (b), and ethylidenenorbornene (c) is 64/34/2 at molar ratio; weight average molecular weight (Mw) is 180,000.
- *2: 1,4-polybutadiene; Mooney viscosity ML_{1+4} (100° C) of 45
- 5 M; weight average molecular weight (Mw) of 490,000.
- *3: 2,4-diamino-6[2'-methylimidazoliny1-(1)']ethyl-s-triadine.
- *4: 2-methyl-4-ethylimidazoline.
- *5: ethyleneglycolmonomethylether.
- 10 *6: 2-amino-2-methylpropanol.
- *7: n-butyl-4,4-bis(t-butylperoxy)valerate.

From the above results, the samples of Examples that are the sheet-like cleaning compositions each having the

15 weight average molecular weight (Mw) within the specific range exhibited the filling ratio of 100%, which is a remarkably excellent filling property. In contrast, the samples of Comparative Examples that are the sheet-like cleaning compositions each having the weight average

20 molecular weight (Mw) out of the specific range has the filling ratio lower than that of Examples, and it is difficult to put Comparative Examples into practical use due to the inferior filling property.

Hereinafter, Examples using the sheet-like mold

25 cleaning composition provided with the slits will be described.

Example 7

As shown in Fig. 1, each of the sheet-like mold cleaning compositions (thickness (T in Fig. 1) of 5 mm) obtained in Examples 1 to 6 described above was cut into sheets 10 each having a width (A in Fig. 1) of 230 mm and a length (B in Fig. 1) of 300 mm. Slits 11 each having a depth of 4.5 mm were formed in a direction of the width of the sheet 10 on a whole part of an upper surface of the sheet 10 at an interval (C in Fig. 1) of 15 mm and in parallel to each other. Namely, a distance (D in Fig. 3) between an end of each of the slits 11 and a sheet surface of the sheet 10 facing to the end was 0.5 mm. In this sheet 10, twenty block pieces 10a were formed. Each of the sheet-like mold cleaning compositions 10 provided with the slits 11 was cut in accordance with several types of transfer molding apparatuses that varied in mold size and folded at a part of the slits 11 to be placed in the molds as being stacked. After that, the mold was closed to perform heat molding for measuring a filling ratio. As a result, it was detected that the filling ratio was high and the filling property was remarkably excellent like the foregoing sheet-like mold cleaning composition.

The mold cleaning composition of the invention is useful for cleaning and recycling molds such as those used for a thermosetting resin molding material, for example,

for cleaning and recycling a mold for transfer molding which is used for molding semiconductor elements by transfer molding using an epoxy resin molding material.

While the present invention has been described in
5 detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the scope thereof.

This application is based on Japanese patent
10 application No. 2006-145544 filed on May 25, 2006, the entire contents thereof being hereby incorporated by reference.

Further, all references cited herein are incorporated in their entireties.

WHAT IS CLAIMED IS:

1. A mold cleaning composition comprising an unvulcanized rubber, a cleaning agent, and a vulcanizing agent, wherein said cleaning composition as a whole has a weight average molecular weight (Mw) within a range of from 200,000 to 460,000 according to the measurement by gel permeation chromatography (GPC).

2. The mold cleaning composition according to claim 1, wherein said cleaning composition as a whole has a weight average molecular weight (Mw) within a range of from 220,000 to 430,000 according to the measurement by gel permeation chromatography (GPC).

3. The mold cleaning composition according to claim 1 or 2, which has a sheet-like shape or a strip shape.

4. The mold cleaning composition according to any one of claims 1 to 3, wherein the cleaning agent is at least one member selected from the group consisting of glycolether, imidazole, imidazoline, and aminoalcohol.

5. The mold cleaning composition according to any one of claims 1 to 4, wherein the cleaning agent is contained in an amount of from 10 to 60 parts by weight with respect to 100 parts by weight of the unvulcanized rubber.

6. The mold cleaning composition according to any one of claims 1 to 5, which further comprises water in an amount of from 1 to 20 wt%.

7. The mold cleaning composition according to any one of claims 1 to 6, which further comprises a release agent.

8. The mold cleaning composition according to any one of claims 1 to 7, wherein the mold cleaning composition has a sheet-like shape in which a plurality of linear slits are disposed on a sheet surface thereof in one direction at a predetermined interval and in parallel with each other.

9. The mold cleaning composition according to claim 8, wherein said slits are disposed so that said sheet-like mold cleaning composition is capable of being folded.

10. The mold cleaning composition according to claim 8, wherein said slits are disposed so that said sheet-like mold cleaning composition is capable of being cut along said slits.

11. The mold cleaning composition according to any one of claims 1 to 10, which is a cleaning composition to be used for a mold used for heat molding repeatedly for molding a molding material.