

DESCRIPTION

MOLD CLEANING RUBBER COMPOSITION

Technical Field

[0001]

5 This invention relates to a mold cleaning rubber composition and more particularly a mold cleaning resin composition used to clean the surface of a mold to remove stains deposited during molding of a curing resin, the composition being characterized by containing a specific unvulcanized rubber as a base resin.

Background Art

10 [0002]

 When encapsulation molding of integral circuits, etc. with a thermosetting resin such as an epoxy resin is continued for a long time, cases not infrequently occur in which the inner surface of the mold is stained, and continuation of molding with such a stained mold results in contamination of the surface of the molded products or adhesion
15 of the molded product to the mold surface, making further shots impossible. Therefore, a mold should be cleaned periodically. It has been proposed to clean a mold by making a few shots with a mold cleaning resin per several hundreds of shots with a molding material. For example, JP 52-788B discloses a method of cleaning a mold by molding a mold cleaning resin composition comprising an amino resin, an
20 organic and/or inorganic base material, and a mold release agent.

 A method of cleaning a mold surface using an unvulcanized rubber compound containing a cleaning component in place of the thermosetting melamine resin molding material. According to this method, while the compound is vulcanized in a mold into a vulcanized rubber, a layer of an oxidatively deteriorated substance, such as a release
25 agent, existing on the surface of the mold is decomposed by the cleaning component and integrated into the vulcanized rubber, which is taken out of the mold. A rubber composition containing a butadiene rubber and an ethylene-propylene rubber as unvulcanized rubber components at a ratio of 90/10 to 50/50 by weight has also been proposed (see, for example, JP 63-227308A and JP 4-357007A).

[0003]

Mold cleaning materials are roughly classified into a transfer type and a compression type. Melamine resin molding compounds are used as a transfer type cleaning material. Melamine resin molding compounds and rubber cleaning compounds are used as a compression type cleaning material.

With the recent increasing integration scale and decreasing device thickness and the spreading use of surface mount technology in fabrication of integral circuits, etc. (IC/LSIs), the shapes and structures of molded packages have been increasingly diversified. To cope with this tendency, fluidity and environmental responsiveness of a molding compound for semiconductor encapsulation have been improved.

A high fluidity epoxy molding compound is liable to clog the air vent. If air vent clogging occurs, air is not allowed to escape, and the resin compound does not flow and fails to fill the cavity, making continuous molding difficult. To avoid the problem, cleaning is required. It has been difficult, however, to remove the resin compound clogging the air vent with a transfer type cleaning material because the cleaning resin does not flow normally for the reason described above.

[0004]

To clean a clogged air vent, a compression type cleaning material has been used. Although a melamine resin molding compound of compression type is able to clean the clogged air vent, a molded product obtained therefrom tends to be brittle in its peripheral portion because the resin flows out from the mold and fails to be pressurized sufficiently. This makes removal of the molded product from the mold laborious. On the other hand, a rubber cleaning compound evenly cures to produce a single molded sheet that can easily be removed from the mold, which brings about improved workability. However, a rubber cleaning compound has lower fluidity than a melamine resin molding compound so that it has poor filling properties and is incapable of removing stains from a hard-to-reach part of a mold cavity, such as a corner.

[0005]

When a rubber cleaning compound is applied to molds having deep cavities for

small size packages, such as plastic dual inline packages (hereinafter abbreviated as PDIPs) and small outline integrated circuits (hereinafter abbreviated as SOICs), and particularly molds for small packages with a small number of pins, there is a likelihood that a cured product clings to the mold because of so many cavities per mold. As a
5 result, the molded product of sheet form is liable to chip when removed from the mold and remain in the cavity as debris. If chipping occurs in such a multi-cavity mold, much time is needed to remove the debris from the cavities.

[0006]

To settle down the problems alluded to above, it has been demanded to develop
10 a rubber cleaning material having good workability (mold release) and excellent molding properties not to cause incomplete filling in the corner of a mold cavity and a rubber cleaning material having stretch and strength not to undergo chipping when removed from a mold.

[0007]

15 Patent Document 1: JP 52-788B
Patent Document 2: JP 63-227308A
Patent Document 3: JP 4-357007A

Disclosure of the Invention

[0008]

20 The present invention is contemplated to provide a solution to the problems with conventional rubber cleaning materials that bring void formation or chipping while providing good workability (good mold release) and to provide a rubber cleaning material involving no problem of void formation or chipping.

25 The present invention is also contemplated to provide a solution to the problems with conventional rubber cleaning materials that some have the problem of void formation or chipping while providing good workability (good mold release) and some have the problem of poor workability (poor mold release) to cause chipping while having no problem of void formation and to provide a rubber cleaning material involving no problem of void formation or chipping when applied to molds having deep

cavities for small packages, such as PDIPs and SOICs, particularly those for small packages with a small number of pins.

[0009]

The above objects of the invention have been accomplished by the provision of
5 mold cleaning rubber compositions (1) to (3) below.

- 10 (1) A mold cleaning rubber composition for cleaning a mold to remove a stain formed during molding of a curing resin, the composition containing, as a base resin, an unvulcanized rubber comprising an ethylene-propylene rubber and a butadiene rubber at a mixing ratio of 90/10 to 50/50 by weight. The unvulcanized rubber has a 90% cure time (optimum cure point) $t_c(90)$ in the range of from 50 to 100 seconds at a mold temperature of 175°C and, after cure, an elongation of 80% to 800%, a tensile strength of 3 to 10 MPa, and a rubber hardness (durometer A hardness) of 60 to 95. The mold cleaning rubber composition will be referred to as a first mold cleaning rubber composition.
- 15 (2) A mold cleaning rubber composition for cleaning a mold to remove a stain formed during molding of a curing resin, the composition containing, as a base resin, an unvulcanized rubber comprising an ethylene-propylene rubber and a butadiene rubber at a mixing ratio of 90/10 to 50/50 by weight. The unvulcanized rubber has a 90% cure time (optimum cure point) $t_c(90)$ in the range of from 200 to 400 seconds at a mold
20 temperature of 175°C and, after cure, an elongation of 80% to 800%, a tensile strength of 3 to 10 MPa, and a rubber hardness (durometer A hardness) of 60 to 95. The mold cleaning rubber composition will be referred to as a second mold cleaning rubber composition.
- 25 (3) A mold cleaning rubber composition for cleaning a mold to remove a stain formed during molding of a curing resin, the composition containing, as a base resin, an unvulcanized rubber comprising an ethylene-propylene rubber and a butadiene rubber at a mixing ratio of 90/10 to 50/50 by weight. The unvulcanized rubber has a 90% cure time (optimum cure point) $t_c(90)$ in the range of from 200 to 400 seconds at a mold temperature of 175°C and, after cure, an elongation of 80% to 800%, a tensile strength

of 3 to 10 MPa, and a rubber hardness (durometer A hardness) of 60 to 95. The composition further contains at least one release agent. The mold cleaning rubber composition will be referred to as a third mold cleaning rubber composition.

5 The first, second, and third mold cleaning rubber compositions are excellent in molding properties and strength as well as workability (mold release) and have no problem of void formation or chipping.

[0010]

10 The first, second, and third mold cleaning rubber compositions contain, as a base resin, an unvulcanized rubber having a 90% cure time (optimum cure point) $t_c(90)$ in the range of from 50 to 100 seconds or in the range of from 200 to 400 seconds at a mold temperature of 175°C and, after cure, an elongation of 80% to 800%, a tensile strength of 3 to 10 MPa, and a rubber hardness (durometer A hardness) of 60 to 95. Owing to this characteristic, they easily achieve cleaning of an air vent and also have excellent molding properties and strength while retaining good workability (mold
15 release) characteristic of a rubber cleaning material.

Containing at least one release agent, the third mold cleaning rubber composition of the invention is suited to clean molds having deep cavities for small size packages, such as PDIPs and SOICs, particularly those for small packages with a small number of pins.

20 Best Mode for Carrying out the Invention

[0011]

The first mold cleaning rubber composition of the invention will be described first.

25 The unvulcanized rubber that can be used in the invention is a mixture of an ethylene-propylene rubber and a butadiene rubber. As used herein, the term "ethylene-propylene rubber" (hereinafter abbreviated as EPM) is intended to include both an ordinary ethylene-propylene rubber (EPM) and an ethylene-propylene-diene

rubber (hereinafter abbreviated as EPDM).

[0012]

EPM having an ethylene/ α -olefin (particularly propylene) copolymerization ratio of from 55/45 to 83/17 by mole and a Mooney viscosity ML_{1+4} (100°C) of 5 to 300 is preferably used. EPM having the copolymerization ratio of from 55/45 to 61/39 by mole and a Mooney viscosity ML_{1+4} (100°C) of 36 to 44 is more preferred.

[0013]

EPDM is a terpolymer of ethylene, an α -olefin, and a cyclic or acyclic monomer having a non-conjugated double bond, more particularly a terpolymer of ethylene, an α -olefin (particularly propylene), and a polyene. Examples of the polyene monomer include dicyclopentadiene, 5-cyclooctadiene, 1,7-cyclododecadiene, 1,5,9-cyclododecatriene, 1,4-cycloheptadiene, 1,4-cyclohexadiene, norbornadiene, methylene norbornene, 2-methylpentadiene-1,4, 1,5-hexadiene, 1,6-heptadiene, methyl tetrahydroindene, and 1,4-hexadiene. The copolymerization ratio in the terpolymer is preferably from 30 to 80 mol% ethylene, from 0.1 to 2 mol% polyene, and the rest being an α -olefin. The terpolymer containing 30 to 60 mol% ethylene is more preferred. The Mooney viscosity ML_{1+4} (100°C) of the terpolymer is preferably 20 to 70.

[0014]

The butadiene rubber (hereinafter abbreviated as BR) that can be used in the invention preferably has a high cis structure with a cis-1,4 bond content of 90% by weight or more and a Mooney viscosity ML_{1+4} (100°C) of 20 to 60, more preferably 30 to 45.

[0015]

The ethylene-propylene rubber and the butadiene rubber are used in a mixing ratio of 90/10 to 50/50, preferably 80/20 to 60/40, by part by weight.

An ethylene-propylene rubber content exceeding 90 parts by weight results in

poor mold release, which leads to an increased working time for mold cleaning. If a butadiene rubber content exceeds 50 parts by weight, mold release is improved, but the resulting cured product is hard and brittle and apt to chip.

[0016]

5 A vulcanization-cured product of the unvulcanized rubber has an elongation of 80% to 800%, preferably 100% to 300%. When the elongation is less than 80%, the rubber composition has poor molding properties.

A vulcanization-cured product of the unvulcanized rubber has a tensile strength of 3 to 10 MPa, preferably 5 to 8 MPa. When the tensile strength is less than 3 MPa,
10 chipping occurs.

A vulcanization-cured product of the unvulcanized rubber has a rubber hardness (durometer A hardness) of 60 to 95, preferably 70 to 90. When the rubber hardness is out of the range, the chipping problem or the void formation problem occurs.

The unvulcanized rubber has a 90% cure time (optimum cure point) $tc(90)$ at a
15 mold temperature of 175°C is 50 to 100 seconds, preferably 70 to 100 seconds. When the $tc(90)$ of the unvulcanized rubber is in that range, the rate of cure is not too high to allow the rubber composition to fill every part of a mold cavity, so that mold cleaning is successfully accomplished without troubles, like sticking. Furthermore, cleaning operation is carried out by a more efficient cure schedule compared with a conventional
20 rubber cleaning compound. This leads to reduction of total cleaning time.

[0017]

The rubber composition of the invention may contain, in addition to the unvulcanized rubber, a filler, a cleaning agent, a cleaning aid, a vulcanizing agent, a vulcanization aid, a vulcanization accelerator, a vulcanization acceleration aid, and so
25 on.

[0018]

Examples of useful fillers (reinforcing agents) are silica, alumina, calcium carbonate, aluminum hydroxide, and titanium oxide. The amount of the filler to be used is preferably 10 to 70 parts, more preferably 30 to 60 parts, by weight per 100 parts
5 by weight of the unvulcanized rubber.

Examples of useful cleaning agents include amines, such as monoethanolamine, diethanolamine, triethanolamine, N-methyldiethanolamine, and N,N-di-n-butylethanolamine; glycol ethers, such as ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, and triethylene glycol dimethyl ether; imidazoles; and
10 indazoles. The amount of the cleaning agent to be used is preferably 5 to 50 parts, more preferably 5 to 30 parts, by weight per 100 parts by weight of the unvulcanized rubber. In addition to the cleaning agent, a cleaning aid, such as a surface active agent, may be used.

[0019]

15 Examples of useful vulcanizing agents include organic diallyl peroxides, such as di-t-butyl peroxide, di-t-amyl peroxide, dicumyl peroxide, and 2,5-dimethyl-2,5-di(t-butyl peroxy)hexane; and organic peroxy ketals, such as 1,1-bis(t-butyl peroxy)-3,3,5-trimethylcyclohexane, 1,1-bis(t-butyl peroxy)cyclohexane, 2,2-bis(t-butyl peroxy)octane, n-butyl 4,4-bis(t-butyl peroxy)valerate, and
20 2,2-bis(t-butyl peroxy)butane. Peroxy ketals generally have a longer half-life period than diallyl peroxides. The vulcanizing agents recited above may be used either individually, or a vulcanizing agent with a long half-life period and a vulcanizing agent with a short half-life period may be used in combination to control the rate of cure, which depends on the composition design. The amount of the vulcanizing agent to be
25 used is preferably 1 to 6 parts, more preferably 2 to 4 parts, by weight per 100 parts by weight of the unvulcanized rubber. In addition to the vulcanizing agent, a vulcanization aid, such as an acrylic acid monomer or sulfur, may be used.

[0020]

30 Examples of useful vulcanization accelerators include guanidines, such as diphenylguanidine and triphenylguanidine; aldehyde-amine or aldehyde-ammonia reaction products, such as a formaldehyde-paratoluidine condensate and an

acetaldehyde-aniline reaction product; and thiazoles, such as 2-mercaptobenzothiazole and dibenzothiazyl disulfide. A vulcanization acceleration aid, such as magnesia, litharge, or lime, may also be used.

[0021]

5 If desired, the rubber composition of the invention may further contain an organic or inorganic pigment, such as red oxide, iron blue, iron black, ultramarine blue, carbon black, lithopone, titanium yellow, cobalt blue, Hanza yellow, and quinacridone red; metal soap lubricants, such as zinc stearate, zinc myristate, aluminum stearate, and calcium stearate; fatty acid ester lubricants, such as butyl stearate, butyl laurate, and
10 stearyl stearate; and amide lubricants, such as ethylenebisstearamide, erucamide, oleamide, stearamide, and behenamide.

[0022]

The second mold cleaning rubber composition of the invention is then described.

The second mold cleaning rubber composition is the same as the first one except
15 that the unvulcanized rubber used as a based resin has a 90% cure time (optimum cure point) $tc(90)$ in the range of from 200 to 400 seconds, preferably 250 to 350 seconds, at a mold temperature of 175°C.

The $tc(90)$ value can be adjusted appropriately by the kinds and amounts of the diene monomer, peroxide, vulcanization accelerator, co-crosslinking agent, and so forth.

20 [0023]

When the $tc(90)$ of the unvulcanized rubber is in that range, the rate of cure is not too high to allow the rubber composition to slowly conform to the shape of a cavity when the mold is clamped and to fill every part of the cavity. As a result, mold cleaning is successfully accomplished without troubles, such as incomplete filling and
25 sticking due to a void.

[0024]

The third mold cleaning rubber composition of the invention is then described.

The third mold cleaning rubber composition is the same as the second one except for further containing at least one release agent.

5 [0025]

Examples of useful release agents include metal soap release agents, fatty acid ester release agents, synthetic waxes, and fatty acid amide release agents.

Examples of the metal soap release agents are calcium stearate, zinc stearate, and zinc myristate. The fatty acid ester release agents, synthetic waxes, and fatty acid
10 amide release agents are exemplified by Licowax OP (partially saponified montanic acid ester, from Clariant Japan K.K.), Loxiol G-78 (polymeric complex ester, from Cognis Japan, Ltd.), Licolub H-4 (modified hydrocarbon, from Clariant Japan K.K.), Loxiol VPN881 (mineral oil-based synthetic wax, from Cognis Japan, Ltd.), Amide S (fatty acid amide, from Kao Corp.), Kao Wax EB-P (fatty acid amide, from Kao Corp.),
15 and Alflow HT-50 (fatty acid amide, from NOF Corp.).

The release agent is preferably used in an amount of 3 to 15 parts, more preferably 5 to 10 parts, by weight per 100 parts by weight of the unvulcanized rubber.

Of molds having deep cavities for small sized packages, such as PDIPs and SOICs, those for particularly small packages with a small number of pins have many
20 cavities per mold, and therefore the mold releasability is reduced relatively. The rubber composition with too large an amount of the release agent has good mold release but poor cleaning performance.

[0026]

The first and second mold cleaning rubber composition can be prepared by any
25 known method. For example, EPM and BR are put into a jacketed pressure kneader

and started to be kneaded. Kneading is continued until the EPM/BR mixture becomes a homogeneous rubber mass like glutinous rice cake while monitoring the rubber mass temperature. When the temperature of the rubber mass reaches to 70° to 100°C, white carbon, an amino-alcohol compound, a cyclic amide compound, process oil, a nonionic surface active agent, stearic acid, and the like are added thereto, followed by kneading for an additional few minute period. An organic peroxide, sulfur, and so on are then added and rapidly dispersed, and the resulting rubber mass is taken out of the kneader to provide a mold cleaning rubber composition of the invention. Where necessary, the rubber mass is shaped into an appropriate form, such as a sheet.

10 [0027]

The third mold cleaning rubber composition can be obtained by adding the above-described release agent to the EPM/BR mixture together with other necessary additives in the preparation of the second mold cleaning rubber composition.

[0028]

15 Kneading machines that can be used include a Banbury mixer and a roll mixer in addition to the pressure kneader referred to above.

[0029]

20 While the form of the first, second, and third mold cleaning resin compositions is not particularly limited, they are preferably shaped into a sheet form that is easy to cool in a short time because the rubber mass may undergo accelerated vulcanization by the residual heat after kneading and fail to exhibit stable performance unless it is rapidly cooled after completion of kneading.

Example

[0030]

25 The present invention will now be illustrated in greater detail with reference to Examples, but it should be understood that the invention is not construed as being limited thereto. Unless otherwise noted, all the parts are by weight.

[0031]

Testing methods:

The testing methods used in Examples and Comparative Examples to evaluate various physical properties are as follows.

5 (1) Elongation and tensile strength

Measured in accordance with the method of measuring tensile strength and elongation at break specified in JIS K6251.

(Test specimen)

10 The test specimen was prepared by molding the unvulcanized rubber composition in a 37T automatic press at a mold temperature of 175°C and a molding pressure of 10 MPa (gauge pressure) for a pressing time of 5 minutes into a sample sheet of 80 mm in width, 160 mm in length, and 2 mm in thickness and punching the sheet to make a dumbbell specimen of size No. 3 according to JIS.

[0032]

15 (2) Rubber hardness

Measured in accordance with “Rubber, vulcanized or thermoplastic-Determination of hardness” of JIS K6253. A durometer hardness of a stack of three sample sheets (80x160x2 mm) prepared in the same manner as described in (1) above was measured with a durometer of the type chosen according to the
20 hardness.

[0033]

(3) Rate of cure

The 90% cure time (optimum cure point) $t_{c(90)}$, at a mold temperature of 175°C, of the unvulcanized rubber composition was determined using the method specified in
25 JIS K6300-2, “Determination of cure characteristics with oscillating curemeters”.

[0034]

(4) Mold cleaning test

Five hundred shots of a commercially available biphenyl epoxy resin molding compound (EME-7351T, available from Sumitomo Bakelite Co., Ltd.) were made in a mold for PDIP-14L (8 pots, 48 cavities) to create mold stains. The mold cleaning rubber composition was repeatedly molded in the stained mold until the mold surface was cleaned. In Examples 9 to 12, the evaluation was made using a mold for PDIP-8L (8 pots, 96 cavities).

[0035]

Example 1 (the first mold cleaning rubber composition of the invention)

In a 3000 ml jacketed pressure kneader were put 1050 g of EPDM (Mooney viscosity ML_{1+4} (100°C): 23) and 450 g of BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) and kneaded under pressure for about 3 minutes while cooling, whereby the mixture became a homogeneous rubber mass having a temperature of about 80°C. To the mass were added 150 g (10 parts, per 100 parts of the EPDM/BR blend (hereinafter, "parts" means the same)) of monoethanolamine, 75 g (5 parts) of a polyoxyalkylene decyl ether surface active agent, 15 g (1 part) of stearic acid, 750 g (50 parts) of white carbon, 75 g (5 parts) of calcium carbonate, 75 g (5 parts) of titanium oxide, and 75 g (5 parts) of zinc oxide, followed by kneading for about 3 minutes. Finally, 48 g (3.2 parts) of 1,1-bis(t-butyl peroxy)cyclohexane was added, followed by kneading for about 1 minute. The temperature of the rubber mixture was controlled not to exceed 100°C throughout the kneading operation. The resulting rubber mass was rapidly passed through pressure rollers to be shaped into a sheet and to be cooled to 25°C or lower to provide a mold cleaning rubber composition of sheet form of 6 mm in thickness (designated composition A).

The characteristics and the cleaning test results of the composition A are shown in Table 1 below. As can be seen from the test results, the composition A exhibited good cleaning performance.

[0036]

Example 2 (the first mold cleaning rubber composition of the invention)

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition B) was prepared in the same manner as in Example 1, except for changing the amounts of EPDM (Mooney viscosity ML_{1+4} (100°C): 23) and BR

(Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) as base resins to 900 g and 600 g, respectively.

5 The characteristics and the cleaning test results of the composition B are shown in Table 1. The test results prove the composition B to exhibit good cleaning performance.

[0037]

Example 3 (the first mold cleaning resin composition of the invention)

10 A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition C) was prepared in the same manner as in Example 1, except for replacing 150 g (10 parts) of the monoethanolamine with 450 g (30 parts) of ($\pm$)-1-amino-2-propanol.

The characteristics and the cleaning test results of the composition C are shown in Table 1. The test results prove the composition C to exhibit good cleaning performance.

15 [0038]

Example 4 (the first mold cleaning rubber composition of the invention)

20 A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition D) was obtained in the same manner as in Example 1, except for using, as base resins, 825 g of EPDM (Mooney viscosity ML_{1+4} (100°C): 23) and 675 g of BR (Mooney viscosity ML_{1+4} (100°C): 35; 1,4-cis bond content: 95 wt%) and changing the amount of white carbon from 750 g (50 parts) to 450 g (30 parts).

The characteristics and the cleaning test results of the composition D are shown in Table 1. The test results prove the composition D to exhibit good cleaning performance.

25 [0039]

Comparative Example 1

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition E) was obtained in the same manner as in Example 1, except for changing the amounts of the of EPDM (Mooney viscosity ML_{1+4} (100°C): 23) and
 5 BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) to 600 g and 900 g, respectively.

The characteristics and the cleaning test results of the composition E are shown in Table 1. As can be seen from the test results, incomplete filling and chipping occurred, resulting in an increased time for cleaning operation. The cleaning
 10 performance was poor, requiring an increased number of shots to complete cleaning.

[0040]

Table 1

Items	Example 1	Example 2	Example 3	Example 4	Comp. Example 1
	Composition A	Composition B	Composition C	Composition D	Composition E
Ratio of EPDM	70	60	70	55	30
Ratio of BR	30	40	30	45	70
Elongation (%)	270	150	253	98	59
Tensile Strength (MPa)	5.2	4.1	4.9	4.3	4.1
Rubber Hardness	90	91	90	91	92
tc(90) (sec)	60	56	67	54	58
Molding Properties	A	A	A	A	B
Releasability	A	A	A	A	C
Number of Shots Required to Complete Cleaning	4	4	4	4	8

Note:

Rating criteria for evaluating molding properties

15

A: Rate of occurrence of incomplete filling is lower than 3%.

B: Rate of occurrence of incomplete filling is 3% or higher and lower than 10%.

C: Rate of occurrence of incomplete filling is 10% or higher.

Rating criteria for evaluating mold releasability

5

A: Rate of occurrence of chipping is lower than 3%.

B: Rate of occurrence of chipping is 3% or higher and lower than 10%.

C: Rate of occurrence of chipping is 10% or higher.

[0041]

Example 5 (the second mold cleaning rubber composition of the invention)

10

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition F) was obtained in the same manner as in Example 1, except that 48 g (3.2 parts) of the 1,1-bis(t-butyl peroxy)cyclohexane was replaced with 48 g (3.2 parts) of dicumyl peroxide and that the temperature of the rubber mixture was controlled not to exceed 110°C.

15

The characteristics and the cleaning test results of the composition F are shown in Table 2. The test results prove the composition F to have good molding properties and cleaning performance.

[0042]

Example 6 (the second mold cleaning rubber composition of the invention)

20

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition G) was prepared in the same manner as in Example 5, except for changing the amounts of EPDM (Mooney viscosity ML_{1+4} (100°C): 23) and BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) to 900 g and 600 g, respectively.

25

The characteristics and the cleaning test results of the composition G are shown in Table 2. The test results prove the composition G to have good molding properties and cleaning performance.

[0043]

Example 7 (the second mold cleaning rubber composition of the invention)

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition H) was prepared in the same manner as in Example 5, except
 5 for replacing 150 g (10 parts) of monoethanolamine with 300 g (20 parts) of (±)-1-amino-2-propanol and replacing 48 g (3.2 parts) of dicumyl peroxide with 28 g (1.9 parts) of dicumyl peroxide and 20 g (1.3 parts) of n-butyl 4,4-bis(t-butyl peroxy)valerate.

The characteristics and the cleaning test results of the composition H are shown
 10 in Table 2. The test results prove the composition H to have good molding properties and cleaning performance.

[0044]

Example 8 (the second mold cleaning rubber composition of the invention)

A mold cleaning rubber composition of sheet form with a thickness of 6 mm
 15 (designated composition I) was obtained in the same manner as in Example 5, except for replacing 450 g of the BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) with 450 g of BR (Mooney viscosity ML_{1+4} (100°C): 35; 1,4-cis bond content: 95 wt%) and replacing 48 g (3.2 parts) of dicumyl peroxide with 13 g (0.9 parts) of 1,1-bis(t-butyl peroxy)cyclohexane and 35 g (2.3 parts) of dicumyl
 20 peroxide.

The characteristics and the cleaning test results of the composition I are shown in Table 2. The test results prove the composition I to have good molding properties and cleaning performance.

[0045]

25 Comparative Example 2

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition J) was prepared in the same manner as in Example 5, except for changing the amounts of EPDM (Mooney viscosity ML_{1+4} (100°C): 23) and BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) to 600 g and

900 g, respectively.

The characteristics and the cleaning test results of the composition J are shown in Table 2. As can be seen from the test results, incomplete filling of cavities and chipping occurred, resulting in an increased time for cleaning operation. The cleaning performance was poor, requiring an increased number of shots to complete cleaning.

[0046]

Table 2

Items	Example 5	Example 6	Example 7	Example 8	Comp. Example 2
	Composition F	Composition G	Composition H	Composition I	Composition J
Ratio of EPDM	70	60	70	70	40
Ratio of BR	30	40	30	30	60
Elongation (%)	150	120	184	188	54
Tensile Strength (MPa)	5.8	5.2	4.3	4.1	4.4
Rubber Hardness	83	87	75	80	92
tc(90) (sec)	329	297	278	267	58
Molding Properties	A	A	A	A	B
Releasability	A	A	A	A	C
Void	A	A	A	A	C
Number of Shots Required to Complete Cleaning	4	4	4	4	8

Note:

Rating criteria for evaluating void

10

A: Rate of occurrence of void is lower than 3%.

B: Rate of occurrence of void is 3% or higher and lower than 10%.

C: Rate of occurrence of void is 10% or higher.

[0047]

Example 9 (the third mold cleaning rubber composition of the invention)

In a 3000 ml jacketed pressure kneader were put 1050 g of EPDM (Mooney viscosity ML_{1+4} (100°C): 23) and 450 g of BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) and kneaded under pressure for about 3 minutes while cooling, whereby the mixture became a homogeneous rubber mass having a temperature of about 80°C. To the mass were added 150 g (10 parts, per 100 parts of the EPDM/BR blend (hereinafter, "parts" means the same)) of monoethanolamine, 75 g (5 parts) of a polyoxyalkylene decyl ether surface active agent, 15 g (1 part) of stearic acid, 650 g (43 parts) of white carbon, 75 g (5 parts) of calcium carbonate, 75 g (5 parts) of titanium oxide, 75 g (5 parts) of zinc oxide, 75 g (5 parts) of Loxiol G-78 (polymeric complex ester, from Cognis Japan, Ltd.), and 75 (5 parts) of Licolub H-4 (modified hydrocarbon, from Clariant Japan K.K.), followed by kneading for about 3 minutes. Finally, 48 g (3.2 parts) of dicumyl peroxide was added, followed by kneading for about 1 minute. The temperature of the rubber mixture was controlled not to exceed 110°C throughout the kneading operation. The resulting rubber mass was rapidly passed through pressure rollers to be shaped into a sheet and to be cooled to 25°C or lower to provide a mold cleaning rubber composition of sheet form of 6 mm in thickness (designated composition K).

The characteristics and the cleaning test results of the composition K are shown in Table 3. As can be seen from the test results, the composition K exhibited good molding properties and cleaning performance.

[0048]

Example 10 (the third mold cleaning resin composition of the invention)

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition L) was prepared in the same manner as in Example 9, except for replacing the EPDM (Mooney viscosity ML_{1+4} (100°C): 23) with 900 g of EPDM (Mooney viscosity ML_{1+4} (100°C): 8), changing the amount of BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) to 600 g, changing the amounts of Loxiol G-78 and Licolub H-4 to 30 g (2 parts) and 15 g (1 part), respectively, and further adding 15 g (1 part) of zinc stearate.

The characteristics and the cleaning test results of the composition L are shown in Table 3. The test results prove the composition L to exhibit good molding properties and cleaning performance.

[0049]

5 Example 11

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition M) was prepared in the same manner as in Example 9, except for changing the amounts of white carbon and Loxiol G-78 to 700 g (47 parts) and 45 g (3 parts), respectively, replacing 75 g (5 parts) of Licolub H-4 with 30 g (2 parts) of
10 Amide S (fatty acid amide, from Kao Corp.), further adding 75 g (5 parts) of zinc stearate, and replacing 48 g (3.2 parts) of dicumyl peroxide with 48 g (3.2 parts) of 2,5-dimethyl-2,5-di(t-butyl peroxy)hexane.

The characteristics and the cleaning test results of the composition M are shown in Table 3. The test results prove the composition M to exhibit good molding
15 properties and cleaning performance.

[0050]

Example 12

A mold cleaning rubber composition of sheet form with a thickness of 6 mm (designated composition N) was prepared in the same manner as in Example 10, except
20 for replacing 600 g of the BR (Mooney viscosity ML_{1+4} (100°C): 42; 1,4-cis bond content: 95 wt%) with the same amount of BR (Mooney viscosity ML_{1+4} (100°C): 35; 1,4-cis bond content: 95 wt%), changing the amount of white carbon from 650 g (43 parts) to 700 g (47 parts), the amount of zinc stearate from 30 g (2 parts) to 75 g (5 parts), and the amount of Loxiol G-78 from 30 g (2 parts) to 60 g (4 parts), and
25 replacing 48 g (3.2 parts) of dicumyl peroxide with 48 g (3.2 parts) of di(t-butyl peroxy)-m-diisopropylbenzene.

The characteristics and the cleaning test results of the composition N are shown in Table 3. The test results prove the composition N to exhibit good molding properties and cleaning performance.

[0051]

Table 3

Items	Example 9	Example 10	Example 11	Example 12
	Composition K	Composition L	Composition M	Composition N
Ratio of EPDM	70	60	70	60
Ratio of BR	30	40	30	40
Elongation (%)	138	128	157	140
Tensile Strength (MPa)	7.0	6.2	8.3	7.2
Rubber Hardness	87	84	80	84
tc(90) (sec)	306	328	319	328
Moldability	A	A	A	A
Releasability	A	A	A	A
Number of Shots Required to Complete Cleaning	4	4	4	4

Industrial Applicability

5 [0052]

The mold cleaning rubber composition of the invention, which contains an unvulcanized rubber comprising an ethylene-propylene rubber and a butadiene rubber in a mixing ratio of 90/10 to 50/50 by weight and having a 90% cure time (optimum cure point) tc(90) of from 50 to 100 seconds or from 200 to 400 seconds at a mold temperature of 175°C and, after cure, an elongation of 80% to 800%, a tensile strength of 3 to 10 MPa, and a rubber hardness (durometer A hardness) of 60 to 95, exhibits good workability (mold release), undergoes no chipping nor void formation, and is able to easily remove stains of not only cavities, runners and gates but also air vents and parting faces of a mold.

15 [0053]

In particular, the third mold cleaning rubber composition of the invention, which

contains a release agent, is suited to clean molds having a deep cavity for small packages, such as PDIPs and SOICs, particularly those for small packages with a small number of pins.

CLAIMS

1. A rubber composition for cleaning a mold to remove a stain formed during molding of a curing resin, comprising, as a base resin, an unvulcanized rubber comprising an ethylene-propylene rubber and a butadiene rubber in a mixing ratio of 80/20 to 60/40 by weight,
5 the unvulcanized rubber having a 90% cure time (optimum cure point) $t_c(90)$ of 50 to 100 seconds at a mold temperature of 175°C and, after cure, an elongation of 80% to 800%, a tensile strength of 3 to 10MPa, and a rubber hardness (durometer A hardness) of 60 to 95.
- 10 2. A rubber composition for cleaning a mold to remove a stain formed during molding of a curing resin, comprising, as a base resin, an unvulcanized rubber comprising an ethylene-propylene rubber and a butadiene rubber in a mixing ratio of 80/20 to 60/40 by weight,
the unvulcanized rubber having a 90% cure time (optimum cure point) $t_c(90)$ of
15 200 to 400 seconds at a mold temperature of 175°C and, after cure, an elongation of 80% to 800%, a tensile strength of 3 to 10 MPa, and a rubber hardness (durometer A hardness) of 60 to 95.
- 20 3. A rubber composition for cleaning a mold to remove a stain formed during molding of a curing resin, comprising, as a base resin, an unvulcanized rubber comprising an ethylene-propylene rubber and a butadiene rubber in a mixing ratio of 80/20 to 60/40 by weight and at least one release agent,
the unvulcanized rubber having a 90% cure time (optimum cure point) $t_c(90)$ of
200 to 400 seconds at a mold temperature of 175°C and, after cure, an elongation of
80% to 800%, a tensile strength of 3 to 10 MPa, and a rubber hardness (durometer A
25 hardness) of 60 to 95.
4. The rubber composition according to claim 3, wherein the release agent is present in an amount of 3 to 15 parts by weight per 100 parts by weight of the base resin.

5. The rubber composition according to any one of claims 1 to 4, which is of compression type.
- 5 6. The rubber composition according to any one of claims 1 to 5, further comprising at least one of a filler, a cleaning agent, a cleaning aid, a vulcanizing agent, a vulcanization aid, a vulcanization accelerator, and a vulcanization acceleration aid.
7. A method of cleaning a mold comprising using the rubber composition according to any one of claims 1 to 6.