

Description

Background of the Invention

The present invention relates to substantially odor free, UV curable organopolysiloxane compositions useful as release coatings. More particularly, the present invention relates to the use of a polydiorganosiloxane having condensed epoxyorganosiloxy units and haloarylalkylsiloxy units which can provide for substantially odor free UV curable organopolysiloxane release coating compositions.

In copending application EP-A-0 355 381 there is described silicone release coatings having improved differential release characteristics. A principal feature of the release performance of such coating compositions is the presence of phenolalkyl radicals attached to silicon by carbon-silicon bonds resulting from the platinum catalyzed hydrosilylation of allylphenol onto condensed siliconhydridesiloxy units. Although a controlled release effect can be achieved with such silicone coating compositions, it has been found that residual amounts of unreacted allylphenol are often present in the cured coating resulting in an unpleasant phenolic odor.

In copending application EP (10858.7-RD-19356) filed concurrently herewith, improvements in controlled release characteristics of UV curable silicone compositions are achieved without the odor disadvantages of residual allylphenol, by using either C_{8-20} alkyl substituted phenol monomers or readily distillable phenolalkyl substituted disiloxanes as controlled release additives (CRA's).

It would be desirable therefore to provide additional odor-free epoxysilicones, or CRA's for epoxysiloxanes, which would be capable of providing odor-free UV curable epoxysilicone compositions having controlled release characteristics.

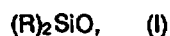
Summary of the Invention

The present invention is based on the discovery that epoxysiloxanes having condensed siloxy units substituted with haloarylalkylene groups attached to silicon by carbon-silicon bonds can provide substantially odor-free UV curable organopolysiloxane compositions exhibiting controlled release characteristics when cured on a paper or plastic substrate.

Statement of the Invention

There is provided by the present invention, a substantially odor-free, UV curable, organopolysiloxane release coating composition comprising (A) poly(epoxyhaloarylalkylsiloxy) selected from the class consisting of

(i) an epoxyhaloarylalkylsiloxy consisting of 20 to 100 condensed siloxy units which includes from 76 to 94 mole percent of diorganosiloxy units of the formula,



from 5 to 12 mole percent of epoxyorganosiloxy units of the formula,



and from 1 to 12 mole percent of haloarylalkylsiloxy units of the formula,



and

(ii) a blend of (i) and epoxysiloxane consisting of 20 to 100 condensed siloxy units which includes from 88 to 95 mole percent of the diorganosiloxy units and from 5 to 12 mole percent of the epoxyorganosiloxy units, and (i) and (ii) of (A) are present therein in an amount which is sufficient to maintain from 76 to 94 mole% of the diorganosiloxy units, from 5 to 12 mole% of the epoxyorganosiloxy units and from 1 to 12 mole% of the haloarylalkylsiloxy units and (B) an effective amount of a polyaryloniumhexafluorometalloid salt selected from diaryliodonium salts and triarylsulfonium salts, where R is a member selected from the same or different $C_{(1-13)}$ monovalent hydrocarbon radicals, and $C_{(1-13)}$ monovalent hydrocarbon radicals substituted with radicals inert during condensation, R^1 is a monovalent epoxy

functional organic radical and R^2 is a monovalent haloarylalkyl radical.

Preferably, the epoxyhaloarylalkylsiloxane consists of from 10 to 50 condensed siloxy units of formulas 1-3. It can be used as a controlled release additive (CRA) when combined with the epoxysiloxane consisting essentially of units of formulas (1) and (2) free of condensed haloarylalkylsiloxane units of formula (3).

Radicals included within R of formulas 1-3, are, for example $C_{(1-8)}$ alkyl radicals, such as methyl, ethyl, propyl, butyl, pentyl, alkenyl radicals such as vinyl, alkyl, cycloaliphatic radicals, for example cycloheptyl cyclohexyl; substituted alkyl, for example trifluoropropyl, cyanoethyl; aryl radicals, such as phenyl, tolyl, xylyl, haloaryl, for example chlorophenyl. Radicals included within R^1 of formula (2) are for example, ethylepoxycyclohexyl, propylglycidyl ether, and 1-methyl-4-isopropyl epoxycyclohexyl. Radicals included within R^2 of formula (3) are, for example, ethylchlorophenyl, ethylbromophenyl and propylchlorophenyl.

The polyaryloniumhexafluorometalloid salts which can be used in the practice of the present invention include group VIa aromatic sulfonium salts as shown by U.S. Patent 4,058,401 and U.S. Patent 4,161,478, Crivello, and hexafluorodiaryliodonium salts shown by Crivello U.S. Patent 4,173,551.

Some of the triarylsulfonium salts are, for example, triphenylsulfoniumhexafluoroarsenate, triphenylsulfoniumhexafluoroantimonate and triarylsulfoniumhexafluorophosphate. Among the diaryliodonium salts which can be used are, for example, diphenyliodoniumhexafluoroarsenate, and diphenyliodoniumhexafluorophosphate. In addition to the aforementioned arylonium salts there also can be used arylonium salts selected from the class consisting of hexafluorophosphates, hexafluoroarsenates and hexafluoroantimonates having at least one aryl radical substituted with a nuclear bound OR group attached to the aryl nucleus by a carbon-oxygen linkage, where R is an alkyl radical having at least 8 carbon atoms. Reference is made to copending application EP-A-0 334 056 which shows additional hexafluoroonium salts which can be employed in the practice of the present invention. An effective amount of the aryl onium salts which can be used is, for example, from .1% to 1.5% by weight and preferably .25% to 1% by weight based on the weight of release coating composition.

The poly(epoxyhaloarylalkylsiloxane) or epoxyhaloarylalkylsiloxanes used in the practice of the present invention can be made by effecting reaction between epoxide monomers having ethylenic unsaturation, and ethylenically unsaturated halogenated aromatic compounds, with organo-hydrogenpolysiloxane in the presence of a catalytic amount of a precious metal, such as a platinum catalyst. Included within the ethylenically unsaturated epoxy monomers which can be employed to make the epoxysiloxanes used in the practice of the present invention are commercially available materials such as 1-methyl-4-isopropenylcyclohexene oxide, 2,6-dimethyl-2,3-epoxy-7-octene, 1,4-dimethyl-4-vinylcyclohexene oxide and vinylcyclohexene monoxide. Vinylcyclohexene oxide is the preferred ethylenically unsaturated epoxide which can be used. Included among the ethylenically unsaturated halogenated aromatic compounds are, for example, chlorostyrene and bromostyrene.

Addition between the ethylenically unsaturated monomers and the SiH functional groups of the organohydrogen polysiloxane can be effected in accordance with the procedure shown by Eckberg U.S. Patent 4,279,717, employing an effective amount of the platinum metal catalyst. In order to maintain the desired mole percent range of epoxy functionality and haloarylalkyl functionality in the epoxyhaloarylalkylsiloxane, there can be used various organohydrogenpolysiloxanes which preferably are methylhydrogenpolysiloxane fluids. For example, in instances where 10 mole percent of epoxyorgano functional siloxy units, and 10 mole percent of haloarylalkylsiloxane units are desired, a methylhydrogenpolysiloxane can be used having a chain length of 100 chemically combined siloxy units and 80 mole percent of dimethylsiloxane units and 20 mole percent of methylhydrogensiloxane units chain-stopped with dimethylhydrogensiloxane units or trimethylsiloxane units.

The organohydrogenpolysiloxane used in preparing the epoxyhaloarylalkylsiloxane can consist of chemically combined dimethylsiloxane units or diphenylsiloxane units, or methylphenylsiloxane units and organosiloxane units having hydrogen attached to silicon, such as methylsiloxane units or phenylsiloxane units and chain-stopped with triorganosiloxane units, such as trimethylsiloxane units or diorganosiloxane units, such as dimethylhydrogensiloxane units having from 10 to 40 condensed siloxy units as previously defined. Hydrosilylation can be effected by the use of a platinum catalyst for example, chloroplatinic acid, finely divided platinum metal, platinum metal on a carrier, such as carbon as shown by Bailey, U.S. Patent 2,970,150, platinum catalyst is shown by Ashby, U.S. Patents 3,159,601 and 3,159,662, Lamoreaux, U.S. Patent 3,220,972 and Karstedt, U.S. Patent 3,775,452 all of which are incorporated herein by reference.

UV curable organopolysiloxane compositions of the present invention can be applied to various substrates by conventional means, such as roller coating, dip coating and spraying. The UV curable organopolysiloxane compositions can be applied, for example, on paper, metals, foils, glass, as well as polymer coated papers such as polyolefin coated kraft paper, polyolefin films, such as polyethylene and polypropylene films and polyester films.

Cure of the applied coatings can be effected by photopolymerization of the UV curable organopolysiloxane compositions upon exposure to a radiation source within the ultraviolet and visible regions. Some of the radiation sources are, for example, mercury, xenon, carbon arc and tungsten filament lamps, sunlight, etc. Exposures can be from less than one second to 10 minutes of more depending upon the materials to be polymerized and photocatalysts employed. Electron beam irradiation also can be used.

In order that those skilled in the art will be better able to practice the present invention, the following examples are given by way of illustration and not by way of limitation. All parts are by weight unless otherwise specified.

Example 1

A controlled release agent (CRA) was prepared in accordance with the practice of the invention, by adding dropwise, 1.039 grams of chlorostyrene to a mixture heated to 65°C, consisting of 10 grams of a silconhydride fluid consisting of about 20 condensed dimethylsiloxy units, 3 condensed methylhydrogen-siloxy units and chain-stopped with trimethylsiloxy units, and two drops of a platinum catalyst in the form of a reaction product of chloroplatinic acid and octanol. The resulting mixture was stirred for one half hour and then 0.9375 grams of vinylcyclohexene monoxide was added dropwise. After three hours, there were then added, 0.1 gram of hexene, 0.5 gram of tetramethylurea, 0.5 gram of dodecanethiol. The solvent was removed under vacuo and light ends were removed by stripping at 120°C. Based on method of preparation, there was obtained a polymethylsiloxane fluid having chemically combined epoxycyclohexenylethylsiloxy units, and chlorophenylethylsiloxy units.

Several blends were made by mixing the above CRA and an epoxypolydimethylsiloxane having 7 mole percent of methylepoxycyclohexylethylsiloxy units and a viscosity of 250 centipoise at 25°C. The blends were diluted with acetone/hexane to 20% solids by weight and catalyzed with 1-3% by weight of a (4-octylphenyl) phenyliodoniumhexafluoroantimonate as part of a 1:1 mixture with 2-ethyl-1,3-hexanediol. The resulting release coating compositions were then applied onto polyethylene kraft using a coating rod and dried and cured by exposure to a mercury vapor lamp at 300 watts/at 50 feet/minute. Laminates were prepared from the resulting coated liner with an aggressive solvent cast rubber based (SBR) pressure sensitive adhesive. The laminates were separated using a pull of 300 inches/minute 180° angle. The following release values in units grams/2 inches were obtained, where UE is the epoxypolydimethylsiloxane free of the CRA.

Table 1

g of CRA	g of UE	Release 3 week data
---	1.0	45-50
0.25	0.75	80-90
0.50	0.50	145-155
0.75	0.25	175-185
1.0	---	195-205

The above results show that epoxysiloxane fluids having condensed methyl-chlorophenylethylsiloxy units and condensed methylepoxycyclohexylethylsiloxy units can function as a valuable CRA when blended with conventional epoxypolydimethylsiloxanes. In addition, the uncured UV curable coating compositions, as well as the cured coatings were substantially odor free.

Claims

1. A substantially odor-free, UV curable, organopolysiloxane release coating composition comprising (A) poly(epoxyhaloarylalkylsiloxy) selected from the class consisting of
 - (i) an epoxyhaloarylalkylsiloxy consisting of 20 to 100 condensed siloxy units selected from 76 to 94 mole percent of diorganosiloxy units of the formula,



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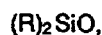
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 - (i) an epoxyhaloarylalkylsiloxane consisting of 20 to 100 condensed siloxyl units selected from 76 to 94 mole percent of diorganosiloxyl units of the formula,



from 5 to 12 mole percent of epoxyorganosiloxyl units of the formula



RR¹SiO₂,

and

from 1 to 12 mole percent of haloarylalkylsiloxo units of the formula

RR²SiO₂,

and

(ii) a blend of (i) and epoxysiloxane consisting of 20 to 100 condensed siloxo units, selected from 88 to 95 mole percent of the diorganosiloxo units and from 5 to 12 mole percent of the epoxyorganosiloxo units and (i) and (ii) of (A) are present therein in an amount which is sufficient to maintain from 76 to 94 mole% of the diorganosiloxo units, from 5 to 12 mole% of the epoxyorganosiloxo units and from 1 to 12 mole% of the haloarylalkylsiloxo units and (B) an effective amount of a polyaryloniumhexafluorometalloid salt selected from diaryliodonium salts and triarylsulfonium salts, where R is a member selected from the same or different C₍₁₋₁₃₎ monovalent hydrocarbon radicals and C₍₁₋₁₃₎ monovalent hydrocarbon radicals substituted with radicals inert during condensation, R¹ is a monovalent epoxy functional organic radical and R² is a monovalent haloarylalkyl radical.

2. A substantially odor free composition in accordance with claim 1, where the polyaryloniumhexafluorometalloid salt is a diaryliodoniumhexafluoroantimonate salt.
3. A substantially odor-free composition in accordance with claim 1, where the polyaryloniumhexafluorometalloid salt is a triarylsulfonium salt.
4. A substantially odor-free composition in accordance with claim 1, where the poly(epoxyhaloarylalkylsiloxane) is a blend of the epoxyhaloarylalkylsiloxane consisting of from 20 to 40 condensed siloxo units, and epoxysiloxane consisting of from 20 to 100 condensed siloxo units.
5. A substantially odor-free composition in accordance with claim 1, where R is methyl, R¹ is epoxycyclohexylethyl and R² is chlorophenylethyl.
6. A substantially odor-free composition in accordance with claim 1, where the poly(epoxyhaloarylalkylsiloxane) is the epoxyhaloarylalkylsiloxane.
7. A substantially odor-free composition in accordance with claim 6, where the epoxyhaloarylalkylsiloxane is an epoxychlorophenylethylsiloxane.
8. A substantially odor-free method for imparting controlled release characteristic onto a paper or plastic substrate which comprises,
 - (1) treating a plastic or paper substrate with a UV curable organopolysiloxane composition and,
 - (2) effecting the cure of the treated plastic or paper substrate by exposing it to UV,
 where the UV curable organopolysiloxane composition is a substantially odor-free, UV curable, organopolysiloxane release coating composition according to claim 1
9. A method in accordance with claim 8, where the substrate is a polyethylene kraft.

Patentansprüche

1. Im wesentlichen geruchlose, UV-härtbare Polyorganosiloxan-Trennmittelüberzugs-Zusammensetzung, umfassend
 - (A) Poly(epoxyhalogenarylalkylsiloxan), ausgewählt aus der Klasse bestehend aus
 - (i) einem Epoxyhalogenarylalkylsiloxan, bestehend aus 20 bis 100 kondensierten Siloxeinheiten, ausgewählt aus 76 bis 94 Mol-% von Diorganosiloxeinheiten der Formel
- (R)₂SiO₂,
- von 5 bis 12 Mol-% Epoxyorganosiloxeinheiten der Formel



RR¹SiO

und

von 1 bis 12 Mol-% Halogenarylalkylsiloxyeinheiten der Formel

RR²SiO

und

(ii) einer Mischung von (i) und Epoxysiloxan, bestehend aus 20 bis 100 kondensierten Siloxyeinheiten, ausgewählt aus 88 bis 95 Mol-% der Diorganosiloxyeinheiten und von 5 bis 12 Mol-% der Epoxyorganosiloxyeinheiten und (i) und (ii) von (A) in einer Menge vorhanden sind, die genügt, um von 76 bis 94 Mol-% der Diorganosiloxyeinheiten, von 5 bis 12 Mol-% der Epoxyorganosiloxyeinheiten und von 1 bis 12 Mol-% der Halogenarylalkylsiloxyeinheiten zu erhalten und

(B) eine wirksame Menge eines Polyaryloniumhexafluornichtmetall- oder -halbmethylsalzes ausgewählt aus Diaryliodoniumsalzen und Triarylsulfoniumsalzen, worin R ausgewählt ist aus den gleichen oder verschiedenen einwertigen C₍₁₋₁₃₎-Kohlenwasserstoffresten und einwertigen C₍₁₋₁₃₎-Kohlenwasserstoffresten, die mit Resten substituiert sind, die während der Kondensation inert sind, R¹ ein einwertiger epoxfunktioneller organischer Rest ist und R² ein einwertiger Halogenarylalkylrest ist.

2. Im wesentlichen geruchsfreie Zusammensetzung nach Anspruch 1, worin das Polyaryloniumhexafluornichtmetall- oder -halbmethylsalz ein Diaryliodoniumhexafluorantimonatsalz ist.
3. Im wesentlichen geruchsfreie Zusammensetzung nach Anspruch 1, worin das Polyaryloniumhexafluorhalbmethyl- oder -nichtmetallsalz ein Triarylsulfoniumsalz ist.
4. Im wesentlichen geruchsfreie Zusammensetzung nach Anspruch 1, worin das Poly-(epoxyhalogenarylalkylsiloxan) eine Mischung des Epoxyhalogenarylalkylsiloxans, bestehend aus 20 bis 40 kondensierten Siloxyeinheiten und des Epoxysiloxans, bestehend aus 20 bis 100 kondensierten Siloxyeinheiten, ist.
5. Im wesentlichen geruchsfreie Zusammensetzung nach Anspruch 1, worin R Methyl ist, R¹ Epoxycyclohexylethyl ist und R² Chlorphenylethyl ist.
6. Im wesentlichen geruchsfreie Zusammensetzung nach Anspruch 1, worin das Poly-(epoxyhalogenarylalkylsiloxan) das Epoxyhalogenarylalkylsiloxan ist.
7. Im wesentlichen geruchsfreie Zusammensetzung nach Anspruch 6, worin das Epoxyhalogenarylalkylsiloxan ein Epoxychlorphenylethylsiloxan ist.
8. Im wesentlichen geruchsfreies Verfahren, um einem Papier- oder Kunststoffsubstrat geregelte Trenn- bzw. Freigabeeigenschaften zu verleihen, umfassend:
 - (1) Behandeln eines Kunststoff- oder Papiersubstrats mit einer UV-härtbaren Polyorganosiloxanzusammensetzung und
 - (2) Härten des behandelten Kunststoff- oder Papiersubstrates, indem man es UV-Licht aussetzt, wobei die UV-härtbare Polyorganosiloxanzusammensetzung eine im wesentlichen geruchsfreie, UV-härtbare Polyorganosiloxan-Trennmittelüberzugs-Zusammensetzung nach Anspruch 1 ist.
9. Verfahren nach Anspruch 8, worin das Substrat ein Polyethylen nach Kraft ist.

50 Revendications

1. Composition de revêtement d'anti-adhérence, à base d'organopolysiloxanes, pratiquement inodore et qui peut durcir sous l'action de rayons UV, comprenant
 - (A) un poly(époxyhalogénoarylalkylsiloxane) choisi dans le groupe constitué par
 - (i) un époxyhalogénoarylalkylsiloxane constitué de 20 à 100 motifs siloxy condensés, choisis parmi 76 à 80 % en moles de motifs diorganosiloxy de formule (R)₂SiO, 5 à 12 % en moles de motifs époxyorganosiloxy de formule RR₁SiO, et 1 à 12 % en moles de motifs halogénoarylalkylsiloxy de formule RR₂SiO, et



- 5 (ii) un mélange du composé (i) et d'un époxysiloxane constitué de 20 à 100 motifs siloxy condensés, choisis parmi 88 à 95 % en moles de motifs diorganosiloxy et 5 à 12 % en moles de motifs époxyorganosiloxy, les composants (i) et (ii) de (A) s'y trouvant en une quantité suffisante pour conserver de 76 à 94 % en moles de motifs diorganosiloxy, de 5 à 12 % en moles de motifs époxyorganosiloxy et de 1 à 12 % en moles de motifs halogénoarylalkylsiloxy, et
- 10 (B) une quantité efficace d'un sel hexafluorométalloïde de polyarylonium, choisi parmi les sels de diaryliodonium et les sels de triarylsulfonium, R représentant un groupe choisi parmi les radicaux hydrocarbonés monovalents en C_{1-13} et les radicaux hydrocarbonés monovalents en C_{1-13} substitués par des groupements inertes au cours de la condensation, lesdits radicaux étant identiques ou différents, R^1 représente un radical organique monovalent à fonction époxy et R^2 représente un radical halogénoarylalkyle monovalent.
- 15 2. Composition pratiquement inodore, conforme à la revendication 1, dans laquelle le sel hexafluorométalloïde de polyarylonium est un hexafluoroantimoniate de diaryliodonium.
3. Composition pratiquement inodore, conforme à la revendication 1, dans laquelle le sel hexafluorométalloïde de polyarylonium est un sel de triarylsulfonium.
- 20 4. Composition pratiquement inodore, conforme à la revendication 1, dans laquelle le poly-(époxyhalogénoarylalkylsiloxy) est un mélange d'un époxylhalogénoarylalkylsiloxy constitué de 20 à 40 motifs siloxy condensés et d'un époxysiloxane constitué de 20 à 100 motifs siloxy condensés.
- 25 5. Composition pratiquement inodore, conforme à la revendication 1, dans laquelle R représente un groupe éthyle, R^1 représente un groupe époxycyclohexyléthyle et R^2 représente un groupe chlorophényléthyle.
6. Composition pratiquement inodore, conforme à la revendication 1, dans laquelle le poly-(époxyhalogénoarylalkylsiloxy) est un époxylhalogénoarylalkylsiloxy.
- 30 7. Composition pratiquement inodore, conforme à la revendication 6, dans laquelle l'époxyhalogénoarylalkylsiloxy est un époxychlorophényléthylsiloxy.
- 35 8. Procédé pratiquement inodore pour conférer des propriétés réglées d'anti-adhérence à un substrat en papier ou en matière plastique, lequel procédé comporte :
- (1) le fait de traiter un substrat en papier ou en matière plastique avec une composition d'organopolysiloxane pouvant durcir sous l'action des rayons UV, et
- (2) le fait de soumettre le substrat de matière plastique ou de papier traité à un durcissement, en l'exposant à des rayons UV,
- 40 et dans lequel la composition d'organopolysiloxane pouvant durcir sous l'action des rayons UV est une composition de revêtement d'anti-adhérence, à base d'organopolysiloxanes, pratiquement inodore et pouvant durcir sous l'action des rayons UV, conforme à la revendication 1.
- 45 9. Procédé conforme à la revendication 8, dans lequel le substrat est un kraft-polyéthylène.
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