

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
8 November 2007 (08.11.2007)

PCT

(10) International Publication Number  
**WO 2007/127016 A1**

(51) International Patent Classification:  
*C07F 7/08* (2006.01) *C08G 77/48* (2006.01)  
*C08G 65/336* (2006.01)

(74) Agents: **BARRESE, Rocco, S.** et al.; Dilworth & Barrese, LLP, 333 Earle Ovington Boulevard, Uniondale, NY 11553 (US).

(21) International Application Number:  
PCT/US2007/007904

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date: 30 March 2007 (30.03.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
11/379,592 21 April 2006 (21.04.2006) US

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (*for all designated States except US*): **MOMENTIVE PERFORMANCE MATERIALS INC.** [US/US]; 187 Danbury Road, Wilton, CT 06897 (US).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **LEATHERMAN, Mark, D.** [US/US]; 66 Town Green Drive, Elmsford, NY 10523 (US). **PENG, Wenqing** [CN/CN]; Room 402, No. 399 Mudan Road, Pudong New District, Shanghai 201203 (CN). **POLICELLO, George, A.** [US/US]; 35 Havell Street, Ossining, NY 10562 (US). **RAJARAMAN, Suresh, K.** [IN/US]; 7 Wesley Court, Newburg, NY 12550 (US). **WAGNER, Roland** [DE/DE]; Himmerichweg 60, 53227 Bonn (DE). **XIA, Zijun** [CN/CN]; #8 Room 1703, 910 Dingxiang Road, Pudong, Shanghai 201203 (CN).

**Published:**

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*



WO 2007/127016 A1

(54) Title: HYDROLYSIS RESISTANT ORGANOMODIFIED SILYLATED SURFACTANTS

(57) Abstract: Organomodified silylated surfactant compositions that exhibit resistance to hydrolysis over a wide pH range.

## HYDROLYSIS RESISTANT ORGANOMODIFIED SILYLATED SURFACTANTS

## FIELD OF THE INVENTION

[0001] The present invention relates to organomodified silylated surfactant compositions that exhibit resistance to hydrolysis over a wide pH range. More particularly the present invention relates to such hydrolysis-resistant organomodified silylated surfactants having a resistance to hydrolysis between a pH of about 2 to a pH of about 12.

## BACKGROUND OF THE INVENTION

[0002] The topical application of liquid compositions to the surfaces of both animate and inanimate objects to effect a desired change involve the processes of controlling wetting, spreading, foaming, detergency, and the like. When used in aqueous solutions to improve the delivery of active ingredients to the surface being treated, trisiloxane-type compounds have been found to be useful in enabling the control of these processes to achieve the desired effect. However, the trisiloxane compounds may only be used in a narrow pH range, ranging from a slightly acidic pH of 6 to a very mildly basic pH of 7.5. Outside this narrow pH range, the trisiloxane compounds are not stable to hydrolysis, undergoing rapid decomposition.

## SUMMARY OF THE INVENTION

[0003] The present invention provides for an organomodified silylated surfactant compound or compositions thereof useful as a surfactant having the general formula:

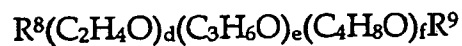


wherein

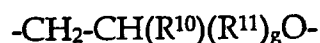
$R^1$ ,  $R^2$ ,  $R^3$ ,  $R^5$ , and  $R^6$  are each independently selected from the group consisting of 1 to 6 monovalent hydrocarbon radicals, aryl, and a hydrocarbon group of 7 to 10 carbons containing an aryl group;

$R^4$  is a hydrocarbon group of 1 to 3 carbons.

$R^7$  is an alkyleneoxide group of the general formula:



where  $R^8$  is a divalent linear or branched hydrocarbon radical having the structure:



where  $R^{10}$  is H or methyl;  $R^{11}$  is a divalent alkyl radical of 1 to 6 carbons where the subscript  $g$  may be 0 or 1;

$R^9$  is selected from the group consisting of H, monovalent hydrocarbon radicals of 1 to 6 carbon atoms and acetyl, subject to the limitation that the subscripts  $d$ ,  $e$  and  $f$  are zero or positive and satisfy the following relationships:

$$2 \leq d + e + f \leq 20 \text{ with } d \geq 2.$$

## DETAILED DESCRIPTION OF THE INVENTION

[0004] As used herein, integer values of stoichiometric subscripts refer to molecular species and non-integer values of stoichiometric subscripts refer to a mixture of molecular species on a molecular weight average basis, a number average basis or a mole fraction basis.

[0005] The present invention provides for an organomodified silylated surfactant compound or compositions thereof useful as a surfactant having the general formula:

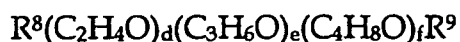


wherein

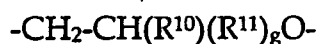
$R^1$ ,  $R^2$ ,  $R^3$ ,  $R^5$ , and  $R^6$  are each independently selected from the group consisting of 1 to 6 carbon atom monovalent hydrocarbon radicals, 6 to 10 carbon atom aryl groups, and a monovalent hydrocarbon group of 7 to 10 carbon atoms containing an aryl group;

$R^4$  is a hydrocarbon group of 1 to 3 carbons;

$R^7$  is an alkyleneoxide group of the general formula:



where  $R^8$  is a divalent linear or branched hydrocarbon radical having the structure:



where  $R^{10}$  is H or methyl;  $R^{11}$  is a divalent alkyl radical of 1 to 6 carbons where the subscript  $g$  may be 0 or 1;

$R^9$  is selected from the group consisting of H, monovalent hydrocarbon radicals of 1 to 6 carbon atoms and acetyl subject to the limitation that the subscripts  $d$ ,  $e$  and  $f$  are zero or positive and satisfy the following relationships:

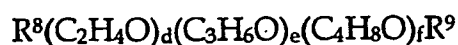
$$2 \leq d + e + f \leq 20 \text{ with } d \geq 2.$$

Preferred embodiments

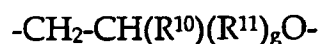
[0006] One preferred embodiment of the organomodified silylated surfactant is where  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^5$ , and  $R^6$  are each independently selected from the group consisting of 1 to 6 monovalent hydrocarbon radicals, aryl, and a hydrocarbon group of 7 to 10 carbons containing or substituted with an aryl group; preferably a hydrocarbon group of 7 to 8 carbons containing an aryl group and more preferably a hydrocarbon group of 7 carbons containing an aryl group;

$R^4$  is a hydrocarbon group of 1 to 3 carbons;

$R^7$  is an alkyleneoxide group of the general formula:



where  $R^8$  is a divalent linear or branched hydrocarbon radical having the structure:



$R^{10}$  is H or methyl;  $R^{11}$  is a divalent alkyl radical of 1 to 6 carbon atoms, more preferably 1 to 2 carbon atoms, where the subscript  $g$  may be 0 or 1;

$R^9$  is selected from the group consisting of H, monovalent hydrocarbon radicals of 1 to 6 carbon atoms and acetyl; more preferably H or methyl, where  $R^7$  is subject to the limitation that the subscripts  $d$ ,  $e$  and  $f$  are zero or positive and satisfy the following relationships:

$2 \leq d + e + f \leq 20$  with  $d \geq 2$ ; with  $d$  preferably ranging from 3 to 20, and more preferably from 5 to 8; with  $e$  preferably ranging from 0 to 10; and more

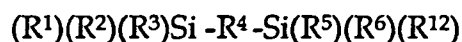
preferably 0 to 5; with  $f$  preferably ranging from 0 to 8, and more preferably from 0 to 4.

[0007] Another preferred embodiment of the organomodified silylated surfactant is where  $R^1, R^2, R^3, R^5,$  and  $R^6$  are each methyl;  $R^4$  is a hydrocarbon group of 1 to 3 carbon atoms;  $R^{10}$  is H;  $R^{11}$  is methyl, where the subscript  $g$  is 1.  $R^9$  is H or methyl. Subscripts  $d, e$  and  $f$  are zero or positive and satisfy the following relationships:

[0008]  $2 \leq d + e + f \leq 17$  with  $d \geq 2$ ; preferably  $d$  ranges from 3 to 9, and more preferably from 5 to 8; preferably  $e$  ranges from 0 to 5; and more preferably 0 to 3; preferably  $f$  is 0 to 2.

[0009] Yet another preferred embodiment of the organomodified silylated surfactant is where  $R^1, R^2, R^3, R^5,$  and  $R^6$  are each methyl;  $R^4$  is a hydrocarbon group of 1 or 2 carbon atoms;  $R^{10}$  is H;  $R^{11}$  is methyl, where the subscript  $g$  is 1; the subscript  $d$  ranges from 6 to 8, both  $e$  and  $f$  are 0.

[0010] One method of producing the composition of the present invention is to react a molecule of the following formula:



where  $R^{12}$  is H, wherein the definitions and relationships are later defined and consistent with those defined above, under hydrosilylation conditions, with an olefinically modified polyalkyleneoxide, such as allyloxypolyethyleneglycol, or methallyloxypolyalkyleneoxide, which are incorporated here as examples, and not set forth to limit other possible olefinically modified alkyleneoxide components. As used herein the phrase "olefinically modified polyalkyleneoxide" is defined as a molecule possessing one or more

alkyleneoxide groups containing one or more, terminal or pendant, carbon-carbon double bonds. The polyether is an olefinically modified polyalkyleneoxide (hereinafter referred to as "polyether") is described by the general formula :



where

$\text{R}^{10}$  is H or methyl;  $\text{R}^{11}$  is a divalent alkyl radical of 1 to 6 carbons where the subscript  $g$  may be 0 or 1;  $\text{R}^9$  is H, a monofunctional hydrocarbon radical of 1 to 6 carbons, or acetyl. When the polyether is composed of mixed oxyalkyleneoxide groups (i.e. oxyethylene, oxypropylene and oxybutylene) the units may be blocked, or randomly distributed. Illustrative examples of blocked configurations are:  $-(\text{oxyethylene})_a(\text{oxypropylene})_b-$ ;  $-(\text{oxybutylene})_c(\text{oxyethylene})_a-$ ;  $-(\text{oxypropylene})_b(\text{oxyethylene})_a(\text{oxybutylene})_c-$ , and the like.

[0011] Non-limiting illustrative examples of the olefinically modified polyalkyleneoxide are:



[0012] Polyether-modified carbosilanes are straightforwardly prepared through the use of a hydrosilylation reaction to graft the olefinically modified

(i.e. vinyl, allyl or methallyl) polyalkyleneoxide onto the hydride (SiH) intermediate of the trisiloxane of the present invention.

[0013] Precious metal catalysts suitable for making polyether-substituted silanes are also well known in the art and comprise complexes of rhodium, ruthenium, palladium, osmium, iridium, and /or platinum. Many types of platinum catalysts for this SiH-olefin addition reaction are known and such platinum catalysts may be used to generate the compositions of the present invention. The platinum compound can be selected from those having the formula  $(PtCl_2Olefin)$  and  $H(PtCl_3Olefin)$  as described in U.S. Pat. No. 3,159,601, hereby incorporated by reference. A further platinum containing material can be a complex of chloroplatinic acid with up to 2 moles per gram of platinum of a member selected from the class consisting of alcohols, ethers, aldehydes and mixtures thereof as described in U.S. Pat. No. 3,220,972, hereby incorporated by reference. Yet another group of platinum containing materials useful in this present invention is described in U.S. Pat. Nos. 3,715,334; 3,775,452 and 3,814,730 (Karstedt). Additional background concerning the art may be found in J.L. Spier, "Homogeneous Catalysis of Hydrosilation by Transition Metals", in *Advances in Organometallic Chemistry*, volume 17, pages 407 through 447, F.G.A. Stone and R. West editors, published by Academic Press (New York, 1979). Those skilled in the art can easily determine an effective amount of platinum catalyst. Generally an effective amount ranges from about 0.1 to 50 parts per million of the total organomodified silylated surfactant composition.

#### USES FOR THE COMPOSITIONS OF THE PRESENT INVENTION:

A. Pesticide - Agriculture, Horticulture, Turf, Ornamental and Forestry

[0014] Many pesticide applications require the addition of an adjuvant to the spray mixture to provide wetting and spreading on foliar surfaces. Often that adjuvant is a surfactant, which can perform a variety of functions, such as increasing spray droplet retention on difficult to wet leaf surfaces, enhance spreading to improve spray coverage, or to provide penetration of the herbicide into the plant cuticle. These adjuvants are provided either as a tank-side additive or used as a component in pesticide formulations.

[0015] Typical uses for pesticides include agricultural, horticultural, turf, ornamental, home and garden, veterinary and forestry applications.

[0016] The pesticidal compositions of the present invention also include at least one pesticide, where the organomodified silylated surfactant of the present invention is present at an amount sufficient to deliver between 0.005% and 2% to the final use concentration, either as a concentrate or diluted in a tank mix. Optionally the pesticidal composition may include excipients, cosurfactants, solvents, foam control agents, deposition aids, drift retardants, biologicals, micronutrients, fertilizers and the like. The term pesticide means any compound used to destroy pests, e.g., rodenticides, insecticides, miticides, fungicides, and herbicides. Illustrative examples of pesticides that can be employed include, but are not limited to, growth regulators, photosynthesis inhibitors, pigment inhibitors, mitotic disrupters, lipid biosynthesis inhibitors, cell wall inhibitors, and cell membrane disrupters. The amount of pesticide employed in compositions of the invention varies with the type of pesticide employed. More specific examples of pesticide compounds that can be used with the compositions of the invention are, but not limited to, herbicides and growth regulators, such as phenoxy acetic acids, phenoxy propionic acids, phenoxy butyric acids, benzoic acids, triazines and s-triazines, substituted ureas, uracils,

bentazon, desmedipham, methazole, phenmedipham, pyridate, amitrole, clomazone, fluridone, norflurazone, dinitroanilines, isopropalin, oryzalin, pendimethalin, prodiamine, trifluralin, glyphosate, sulfonyleureas, imidazolinones, clethodim, diclofop-methyl, fenoxaprop-ethyl, fluazifop-p-butyl, haloxyfop-methyl, quizalofop, sethoxydim, dichlobenil, isoxaben, and bipyridylium compounds.

[0017] Fungicide compositions that can be used with the present invention include, but are not limited to, aldimorph, tridemorph, dodemorph, dimethomorph; flusilazol, azaconazole, cyproconazole, epoxiconazole, furconazole, propiconazole, tebuconazole and the like; imazalil, thiophanate, benomyl carbendazim, chlorothalonil, dicloran, trifloxystrobin, fluoxystrobin, dimoxystrobin, azoxystrobin, furcaranil, prochloraz, flusulfamide, famoxadone, captan, maneb, mancozeb, dodicin, dodine, and metalaxyl.

[0018] Insecticide, larvacide, miticide and ovacide compounds that can be used with the composition of the present invention, but not limited to, *Bacillus thuringiensis*, spinosad, abamectin, doramectin, lepimectin, pyrethrins, carbaryl, primicarb, aldicarb, methomyl, amitraz, boric acid, chlordimeform, novaluron, bistrifluron, triflumuron, diflubenzuron, imidacloprid, diazinon, acephate, endosulfan, kelevan, dimethoate, azinphos-ethyl, azinphos-methyl, izoxathion, chlorpyrifos, clofentezine, lambda-cyhalothrin, permethrin, bifenthrin, cypermethrin and the like.

[0019] The pesticide may be a liquid or a solid. If a solid, it is preferable that it is soluble in a solvent, or the organomodified silylated surfactant of the present invention, prior to application, and the organomodified silylated surfactant may act as a solvent, or surfactant for such solubility or additional surfactants may perform this function.

Agricultural Excipients:

[0020] Buffers, preservatives and other standard excipients known in the art also may be included in the composition.

[0021] Solvents may also be included in compositions of the present invention. These solvents are in a liquid state at room temperature. Examples include water, alcohols, aromatic solvents, oils (i.e. mineral oil, vegetable oil, silicone oil, and so forth), lower alkyl esters of vegetable oils, fatty acids, ketones, glycols, polyethylene glycols, diols, paraffinics, and so forth. Particular solvents would be 2, 2, 4-trimethyl, 1-3-pentane diol and alkoxyated (especially ethoxyated) versions thereof as illustrated in US Patent No. 5,674,832 herein incorporated by reference, or N-methyl-pyrrolidone.

Cosurfactants:

[0022] Moreover, other cosurfactants, which have short chain hydrophobes that do not interfere with superspreading as described in US Patent No. 5,558,806 are herein included by reference.

[0023] The cosurfactants useful herein include nonionic, cationic, anionic, amphoteric, zwitterionic, polymeric surfactants, or any mixture thereof. Surfactants are typically hydrocarbon based, silicone based or fluorocarbon based.

[0024] Useful surfactants include alkoxyates, especially ethoxyates, containing block copolymers including copolymers of ethylene oxide, propylene oxide, butylene oxide, and mixtures thereof; alkylarylalkoxyates, especially ethoxyates or propoxyates and their derivatives including alkyl phenol ethoxyate; arylarylalkoxyates, especially ethoxyates or propoxyates, and their

derivatives; amine alkoxylates, especially amine ethoxylates; fatty acid alkoxylates; fatty alcohol alkoxylates; alkyl sulfonates; alkyl benzene and alkyl naphthalene sulfonates; sulfated fatty alcohols, amines or acid amides; acid esters of sodium isethionate; esters of sodium sulfosuccinate; sulfated or sulfonated fatty acid esters; petroleum sulfonates; N-acyl sarcosinates; alkyl polyglycosides; alkyl ethoxylated amines; and so forth.

[0025] Specific examples include alkyl acetylenic diols (SURFONYL- Air Products), pyrrolidone based surfactants (e.g., SURFADONE - LP 100 - ISP), 2-ethyl hexyl sulfate, isodecyl alcohol ethoxylates (e.g., RHODASURF DA 530 - Rhodia), ethylene diamine alkoxylates (TETRONICS - BASF), and ethylene oxide/propylene oxide copolymers (PLURONICS - BASF) and Gemini type surfactants (Rhodia).

[0026] Preferred surfactants include ethylene oxide/propylene oxide copolymers (EO/PO); amine ethoxylates; alkyl polyglycosides; oxo-tridecyl alcohol ethoxylates, and so forth.

[0027] In a preferred embodiment, the agrochemical composition of the present invention further comprises one or more agrochemical ingredients. Suitable agrochemical ingredients include, but not limited to, herbicides, insecticides, growth regulators, fungicides, miticides, acaricides, fertilizers, biologicals, plant nutritionals, micronutrients, biocides, paraffinic mineral oil, methylated seed oils (i.e. methylsoyate or methylcanolate), vegetable oils (such as soybean oil and canola oil), water conditioning agents such as Choice<sup>®</sup> (Loveland Industries, Greeley, CO) and Quest (Helena Chemical, Collierville, TN), modified clays such as Surround<sup>®</sup> (Englehard Corp.), foam control agents, surfactants, wetting agents, dispersants, emulsifiers, deposition aids, antidrift components, and water.

[0028] Suitable agrochemical compositions are made by combining, in a manner known in the art, such as by mixing, one or more of the above components with the organomodified silylated surfactant of the present invention, either as a tank-mix, or as an "in-can" formulation. The term "tank-mix" means the addition of at least one agrochemical to a spray medium, such as water or oil, at the point of use. The term "in-can" refers to a formulation or concentrate containing at least one agrochemical component. The "in-can" formulation may then be diluted to use concentration at the point of use, typically in a tank-mix, or it may be used undiluted.

#### B. Coatings

[0029] Typically, coatings formulations will require a wetting agent or surfactant for the purpose of emulsification, compatibilization of components, leveling, flow and reduction of surface defects. Additionally, these additives may provide improvements in the cured or dry film, such as improved abrasion resistance, antiblocking, hydrophilic and hydrophobic properties. Coating formulations may exist as solvent-borne coatings, water-borne coatings and powder coatings.

[0030] The coatings components may be employed as architecture coatings, OEM product coatings such as automotive coatings and coil coatings, special purpose coatings such as industrial maintenance coatings and marine coatings. Typical synthetic resin types for coatings substrates include polyesters, polyurethanes, polycarbonates, acrylics and epoxies.

#### C. Personal Care

[0031] In a preferred embodiment, the organomodified silylated surfactant of the present invention comprises, per 100 parts by weight ("pbw") of the

personal care composition, from 0.1 to 99 pbw, more preferably from 0.5 pbw to 30 pbw and still more preferably from 1 to 15 pbw of the organomodified silylated surfactant and from 1 pbw to 99.9 pbw, more preferably from 70 pbw to 99.5 pbw, and still more preferably from 85 pbw to 99 pbw of the personal care composition.

[0032] The organomodified silylated surfactant compositions of the present invention may be utilized in personal care emulsions, such as lotions, and creams. As is generally known, emulsions comprise at least two immiscible phases, one of which is continuous and the other discontinuous. Further, emulsions may be liquids with varying viscosities or solids. Additionally the particle size of the emulsions may render them microemulsions, and when the particle sizes are sufficiently small, microemulsions may be transparent. Further, it is also possible to prepare emulsions of emulsions and these are generally known as multiple emulsions. These emulsions may be:

1) aqueous emulsions where the discontinuous phase comprises water and the continuous phase comprises the organomodified silylated surfactant of the present invention;

2) aqueous emulsions where the discontinuous phase comprises the organomodified silylated surfactant of the present invention and the continuous phase comprises water;

3) non-aqueous emulsions where the discontinuous phase comprises a non-aqueous hydroxylic solvent and the continuous phase comprises the organomodified silylated surfactant of the present invention; and

4) non-aqueous emulsions where the discontinuous phase comprises the organomodified silylated surfactant of the present invention and the continuous phase comprises a non-aqueous hydroxylic organic solvent.

[0033] Non-aqueous emulsions comprising a silicone phase are described in US patent 6,060,546 and US patent 6,271,295, the disclosures of which are herewith and hereby specifically incorporated by reference.

[0034] As used herein, the term "non-aqueous hydroxylic organic compound" means hydroxyl-containing organic compounds exemplified by alcohols, glycols, polyhydric alcohols and polymeric glycols, and mixtures thereof that are liquid at room temperature, e.g. about 25 °C, and about one atmosphere pressure. The non-aqueous organic hydroxylic solvents are selected from the group consisting of hydroxyl-containing organic compounds comprising alcohols, glycols, polyhydric alcohols and polymeric glycols, and mixtures thereof that are liquid at room temperature, e.g. about 25 °C, and about one atmosphere pressure. Preferably the non-aqueous hydroxylic organic solvent is selected from the group consisting of ethylene glycol, ethanol, propyl alcohol, iso-propyl alcohol, propylene glycol, dipropylene glycol, tripropylene glycol, butylene glycol, iso-butylene glycol, methyl propane diol, glycerin, sorbitol, polyethylene glycol, polypropylene glycol mono alkyl ethers, polyoxyalkylene copolymers and mixtures thereof.

[0035] Once the desired form is attained whether as a silicone only phase, an anhydrous mixture comprising the silicone phase, a hydrous mixture comprising the silicone phase, a water-in-oil emulsion, an oil-in-water emulsion, or either of the two non-aqueous emulsions or variations thereon, the resulting material is usually a cream or lotion with improved deposition properties and good feel characteristics. It is capable of being blended into formulations for hair

care, skin care, antiperspirants, sunscreens, cosmetics, color cosmetics, insect repellants, vitamin and hormone carriers, fragrance carriers and the like.

[0036] The personal care applications where the organomodified silylated surfactant of the present invention and the silicone compositions derived therefrom of the present invention may be employed include, but are not limited to, deodorants, antiperspirants, antiperspirant/deodorants, shaving products, skin lotions, moisturizers, toners, bath products, cleansing products, hair care products such as shampoos, conditioners, mousses, styling gels, hair sprays, hair dyes, hair color products, hair bleaches, waving products, hair straighteners, manicure products such as nail polish, nail polish remover, nails creams and lotions, cuticle softeners, protective creams such as sunscreen, insect repellent and anti-aging products, color cosmetics such as lipsticks, foundations, face powders, eye liners, eye shadows, blushes, makeup, mascaras and other personal care formulations where silicone components have been conventionally added, as well as drug delivery systems for topical application of medicinal compositions that are to be applied to the skin.

[0037] In a preferred embodiment, the personal care composition of the present invention further comprises one or more personal care ingredients. Suitable personal care ingredients include, for example, emollients, moisturizers, humectants, pigments, including pearlescent pigments such as, for example, bismuth oxychloride and titanium dioxide coated mica, colorants, fragrances, biocides, preservatives, antioxidants, anti-microbial agents, anti-fungal agents, antiperspirant agents, exfoliants, hormones, enzymes, medicinal compounds, vitamins, salts, electrolytes, alcohols, polyols, absorbing agents for ultraviolet radiation, botanical extracts, surfactants, silicone oils, organic oils, waxes, film formers, thickening agents such as, for example, fumed silica or hydrated silica,

particulate fillers, such as for example, talc, kaolin, starch, modified starch, mica, nylon, clays, such as, for example, bentonite and organo-modified clays.

[0038] Suitable personal care compositions are made by combining, in a manner known in the art, such as, for example, by mixing, one or more of the above components with the organomodified silylated surfactant. Suitable personal care compositions may be in the form of a single phase or in the form of an emulsion, including oil-in-water, water-in-oil and anhydrous emulsions where the silicone phase may be either the discontinuous phase or the continuous phase, as well as multiple emulsions, such as, for example, oil-in-water-in-oil emulsions and water-in-oil-in water-emulsions.

[0039] In one useful embodiment, an antiperspirant composition comprises the organomodified silylated surfactant of the present invention and one or more active antiperspirant agents. Suitable antiperspirant agents include, for example, the Category I active antiperspirant ingredients listed in the U.S. Food and Drug Administration's October 10, 1993 Monograph on antiperspirant drug products for over-the-counter human use, such as, for example, aluminum halides, aluminum hydroxyhalides, for example, aluminum chlorohydrate, and complexes or mixtures thereof with zirconyl oxyhalides and zirconyl hydroxyhalides, such as for example, aluminum-zirconium chlorohydrate, aluminum zirconium glycine complexes, such as, for example, aluminum zirconium tetrachlorohydrate gly.

[0040] In another useful embodiment, a skin care composition comprises the organomodified silylated surfactant, and a vehicle, such as, for example, a silicone oil or an organic oil. The skin care composition may, optionally, further include emollients, such as, for example, triglyceride esters, wax esters, alkyl or alkenyl esters of fatty acids or polyhydric alcohol esters and one or more the

known components conventionally used in skin care compositions, such as, for example, pigments, vitamins, such as, for example, Vitamin A, Vitamin C and Vitamin E, sunscreen or sunblock compounds, such as, for example, titanium dioxide, zinc oxide, oxybenzone, octylmethoxy cinnamate, butylmethoxy dibenzoylm ethane, p-aminobenzoic acid and octyl dimethyl-p-aminobenzoic acid.

[0041] In another useful embodiment, a color cosmetic composition, such as, for example, a lipstick, a makeup or a mascara composition comprises the organomodified silylated surfactant, and a coloring agent, such as a pigment, a water soluble dye or a liposoluble dye.

[0042] In another useful embodiment, the compositions of the present invention are utilized in conjunction with fragrant materials. These fragrant materials may be fragrant compounds, encapsulated fragrant compounds, or fragrance releasing compounds that either the neat compounds or are encapsulated. Particularly compatible with the compositions of the present invention are the fragrance-releasing silicon-containing compounds as disclosed in US patents 6,046,156; 6,054,547; 6,075,111; 6,077,923; 6,083,901; and 6,153,578; all of which are herein and herewith specifically incorporated by reference.

[0043] The uses of the compositions of the present invention are not restricted to personal care compositions, other products such as waxes, polishes and textiles treated with the compositions of the present invention are also contemplated.

#### D. Home Care

[0044] Compositions of the present organomodified silylated surfactant invention are useful in home care applications, including laundry detergent and

fabric softener, dishwashing liquids, wood and furniture polish, floor polish, tub and tile cleaners, toilet bowl cleaners, hard surface cleaners, window cleaners, antifog agents, drain cleaners, auto-dishwashing detergents and sheeting agents, carpet cleaners, prewash spotters, rust cleaners and scale removers.

## EXPERIMENTAL

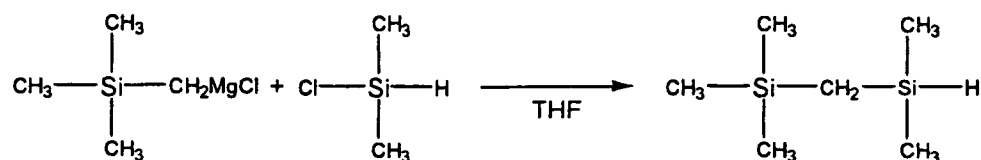
[0045] The hydride intermediates for the organomodified silylated surfactant compositions of the present invention, as well as comparative compositions were prepared as described in the following examples.

### Preparation Example 1

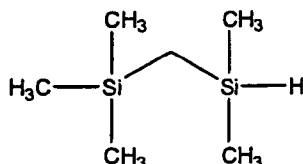
(Trimethylsilylmethyl)dimethylsilane (Figure 1, Structure 1).

[0046] The Grignard reagent of trimethylchloromethylsilane (TMCMS) was prepared by reaction of 12.3 g (0.1 mol) TMCMS and 2.88 g (0.12 mol) magnesium chips in THF (50 mL). The Grignard reagent was then added dropwise into 9.46 g (0.1 mol) dimethylchlorosilane (DMCS), which dissolved in THF (50 mL). The mixture was stirred at room temperature overnight and quenched with 20 mL HCl-acidified water, and then extracted with diethylether (100 mL). The organic layer was washed with distilled water three times and dried with anhydrous sodium sulfate. The mixture was purified by distillation at 118-119 °C to yield 13.0 g (89%) (trimethylsilylmethyl)dimethylsilane product as a clear, colorless fluid.

Figure 1 - Reaction Sequence for Preparation of Hydride Intermediate



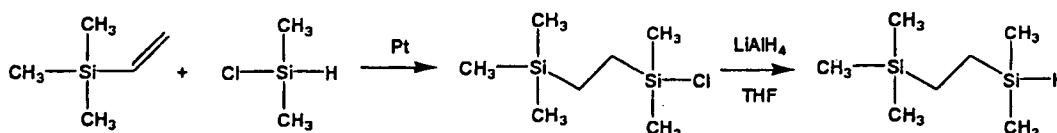
## Structure 1

Preparation Example 2

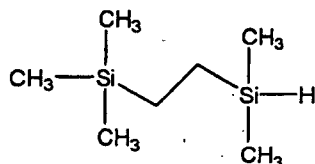
((2-Trimethylsilyl)ethyl)dimethylsilane (Figure 2, Structure 2).

[0047] 10g (0.1 mol) trimethylvinylsilane (TMVS), 9.46g (0.1 mol) dimethylchlorosilane (DMCS) and 10  $\mu$ l platinum(0)-1,3-divinyl-1,1,3,3-tetramethyldisiloxane complex (0.1 M in xylene) were placed into a 100 mL three-necked round bottom flask equipped with N<sub>2</sub> inlet and reflux condenser. The mixture was stirred at room temperature for 30 min and heated to 70 °C for 2h. The reaction was monitored by <sup>1</sup>H NMR. After cooling down to room temperature, 50 mL of THF was introduced and the solution was cooled to -80 °C. 1.00g LiAlH<sub>4</sub> was added to the solution and stirred until the mixture warmed up to room temperature. The mixture was further stirred at room temperature overnight. 10 mL of acidified water was added to quench the reaction, and the organic layer was separated, washed with water three times and dried over anhydrous sodium sulfate. The mixture was purified by distillation, and 12.7 g (yield 79.2%) product was collected at b.p. 140-141 °C as a clear colorless fluid.

Figure 2 - Reaction Sequence for Preparation of Hydride Intermediate



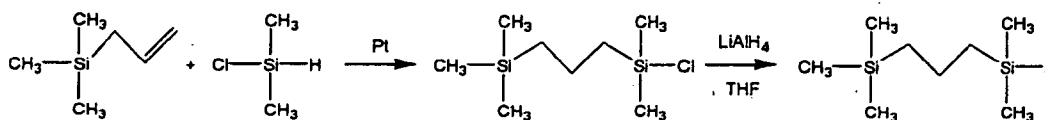
## Structure 2

Preparation Example 3

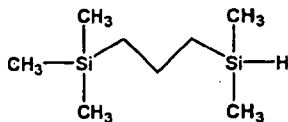
((3-Trimethylsilyl)propyl)dimethylsilane (Figure 3, Structure 3).

[0048] 11.4g (0.1 mol) trimethylallylsilane, 9.5g (0.1 mol) dimethylchlorosilane (DMCS) and 10  $\mu$ l platinum(0)-1,3-divinyl-1,1,3,3-tetramethyldisiloxane complex (0.1 M in xylene) were placed into a 100 mL three-necked round bottom flask equipped with N<sub>2</sub> inlet and condenser. The mixture was stirred at room temperature for 30 min and heated to 70 °C for 2h. The reaction was monitored by <sup>1</sup>H NMR. After cooling down to room temperature, 50 mL of THF was introduced and the solution was cooled to -80 °C. 1.00g LiAlH<sub>4</sub> was added to the solution and stirred until the mixture warmed up to room temperature. The mixture was further stirred at room temperature overnight. 10 mL of acidified water was added to quench the reaction, and the organic layer was separated, washed with water three times and dried over anhydrous sodium sulfate. The mixture was purified by vacuum distillation, and 12.3 g (yield 70.7%) product was collected at b.p. 60-61°C/1-2 mmHg as a clear colorless fluid.

Figure 3 - Reaction Sequence for Preparation of Hydride Intermediate



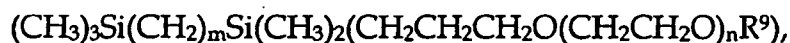
## Structure 3

Preparation Example 4

[0049] The hydride intermediates of Examples 1-3 were further modified with various allylpolyalkyleneoxides to yield the organomodified silylated surfactant compositions of the present invention (Table 1), as well as comparative trisiloxane surfactants (From Table 2).

[0050] The organomodified silylated surfactant compositions of the present invention were prepared by conventional methods of platinum-mediated hydrosilylation, as described in Bailey, U.S. Patent 3,299,112, herein incorporated by reference.

[0051] Table 1 provides a description of the compositions of the present invention. These compositions are described by the general structure:



wherein  $m$ ,  $n$  and  $\text{R}^9$  are described in Table 1.

Table 1-Description of Examples of Organomodified Silylated Surfactant Compositions of the Present Invention

I.D.	$m$	$n$	R
1	1	7.5	$\text{CH}_3$
2	2	7.5	$\text{CH}_3$

3	3	7.5	CH <sub>3</sub>
4	1	7.5	H
5	2	7.5	H
6	1	4	H
7	2	4	H
8	1	11	H
9	2	11	H

Table 2 provides a description of the comparative trisiloxane and organosilicone polyether based surfactants of the general structure:



where  $M = (\text{CH}_3)_3\text{SiO}_{0.5}$ ;  $D = \text{O Si}(\text{CH}_3)_2$ ; and

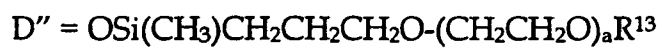


Table 2- Composition of Comparative Organosilicone Polyether Surfactants

I.D.	X	Y	Polyether Group	
			a	R <sup>13</sup>
A	0	1	7.5	CH <sub>3</sub>
B	0	1	7.5	H
C	20	3	7.5	CH <sub>3</sub>

[0052] Additionally, comparative sample OPE (Octylphenoethoxylate, containing 10 polyoxyethylene units) is a non-silicone organic surfactant. This product is available as Triton® X-100 from Dow Chemical Company, Midland, MI.

#### Example 5

[0053] This example demonstrates the ability of the organomodified silylated surfactant compositions of the present invention to reduce aqueous surface tension, thereby showing utility as surfactants. Surface tension was measured using a Kruss surface tensiometer, with a sand blasted platinum blade as the sensor. Solutions of the various components were prepared at 0.1 wt% in 0.005M NaCl water (deionized), as an equilibrium aid.

[0054] Table 3 shows that solutions of these unique compositions provide a significant reduction in surface tension relative to the conventional surfactant.

[0055] The compositions of the present invention also provide spreading properties similar to the comparative trisiloxane surfactants (A, B). Additionally, organomodified silylated surfactants of the present invention provide improved

spreading relative to the conventional silicone polyether (C) and conventional organic surfactant product OPE.

[0056] Spreading was determined by applying a 10  $\mu$ L droplet, of surfactant solution to polystyrene Petri dishes (Fisher Scientific) and measuring the spread diameter (mm) after 30 seconds, at a relative humidity between 50 and 70% (at 22 to 25°C). The solution was applied with an automatic pipette to provide droplets of reproducible volume. Deionized water that was further purified with a Millipore filtration system was used to prepare the surfactant solutions.

Table 3-Surface Tension and Spreading Properties

I.D.	Surface Tension mN/m	Spread Diameter (mm) Weight % Surfactant			
		0.05%	0.1%	0.3%	0.5%
1	24.2	24	41	43	45
2	24.6	27	44	44	45
3	23.8	28	44	44	39
4	24.4	23	36	36	22
5	23.6	27	44	40	33
6	22.5	40	45	53	47
7	22.7	30	42	48	49
8	27.7	nd	7	nd	7
9	26.7	nd	7	nd	7
A	20.9	34	53	51	25
B	20.6	37	53	50	35
C	23.6	nd	nd	nd	6
OPE	31.8	nd	9	nd	10

### Example 6

[0057] Hydrolytic stability was determined for representative compositions of the present invention using HPLC. Solutions of the various compositions were prepared at 0.5 wt% over a pH range from pH 2 to pH 12, and monitored by HPLC for decomposition as a function of time.

Analytical Method:

[0058] The samples were analyzed by a reverse-phase chromatographic technique using the experimental conditions listed in Table 4.

Table 4-Solvent Gradient for HPLC Method

Time (min.)	% Methanol	% Water	% Isopropanol
0.0	70	30	0
15.0	100	0	0
20.0	50	0	50
20.1	70	30	0
25.0	70	30	0

Detector: ELSD/LTA (Evaporative Light Scattering with Low Temperature Adapter)

Conditions: 30°C, 1.95 SLPM N<sub>2</sub>

Column: Phenomenex LUNA C18 end cap, 5 micron, 75x4.6 mm

Flow Rate: 1.0 mL/min.

Inj. Volume: 10 microlitres

Sample: 0.050 g/mL in methanol

[0059] Tables 5-7 demonstrate that the compositions of the present invention provide improved resistance to hydrolytic decomposition relative to the standard comparative siloxane-based surfactant Siloxane A, under similar pH conditions.

[0060] Comparative siloxane A shows rapid hydrolysis at  $\leq$  pH 5 and  $>$  pH 9, while the organomodified silylated surfactants of the present invention demonstrate a higher resistance to hydrolysis under the same conditions.

Table 5-Hydrolytic Stability of Organomodified Silylated Surfactants by HPLC

		Stability: % Silylated Surfactant Remaining						
I.D.	Time	pH 2	pH 4	pH 5	pH 7	pH 9	pH 10	pH 12
1	24h	nd	100	100	100	100	100	nd
	1 wk	100	100	100	100	100	100	77
	2 wk	nd	100	100	100	100	100	nd
	3 wk	100	nd	Nd	nd	nd	nd	73
	4 wk	nd	100	100	100	100	100	nd
	7 wk	89	100	100	100	100	100	76
	12 wk	95	100	100	100	100	100	76
	19 wk	95	100	100	100	100	100	72
	30 wk	73	100	100	100	100	100	74

Table 6-Hydrolytic Stability of Organommodified Silylated Surfactants by HPLC

		Stability: % Silylated Surfactant Remaining						
I.D.	Time	pH 2	pH 4	pH 5	pH 7	pH 9	pH 10	pH 12
2	24h	nd	100	100	100	100	100	nd
	1 wk	100	100	100	100	100	100	77
	2 wk	nd	100	100	100	100	100	nd
	3 wk	100	nd	nd	nd	nd	nd	77
	4 wk	nd	100	100	100	100	100	nd
	7 wk	100	100	100	100	100	100	74
	12 wk	86	100	100	100	100	100	74
	19 wk	79	87	100	100	100	100	77
	30 wk	73	79	90	100	94	97	75

Table 7-Hydrolytic Stability of Comparative Siloxane-Based Surfactants by HPLC

		Stability: % Siloxane Surfactant Remaining				
I.D.	Time	pH 4	pH 5	pH 7	pH 9	pH 10
A	24h	50	93	100	95	75
	48h	22	85	100	88	52
	1 wk	0	58	100	72	12

Example 7

[0061] Unlike traditional siloxane based surfactants, which are subject to rapid hydrolysis under acidic and basic conditions ( $\leq$ pH 5 and  $\geq$  pH 9), the organomodified silylated surfactants of the present invention provide increased resistance to hydrolysis relative to traditional trisiloxane alkoxyates (Comparative Example A). An artifact of hydrolysis is observed as a reduction in spreading properties over time. Therefore, solutions of the organomodified silylated surfactants of the present invention, as well as comparative surfactants, were prepared at desired use levels and pH. Spreading was determined as a function of time to illustrate resistance to hydrolysis.

[0062] Table 8 is an illustrative example of a traditional organomodified trisiloxane ethoxylate surfactant, which exhibits decreased spreading performance with time as a function of hydrolytic decomposition over a pH range from pH 3 to pH 10. Here a 0.4 wt% solution of product A was prepared at pH 3, 4, 5 and 10. Spreading was determined by applying a 10  $\mu$ L droplet of surfactant solution to polyacetate film (USI, "Crystal Clear Write on Film") and measuring the spread diameter (mm) after 30 seconds, at a relative humidity between 50 and 70% (at 22 to 25°C). The solution was applied with an automatic pipette to provide droplets of reproducible volume. Deionized water that was further purified with a Millipore filtration system was used to prepare the surfactant solutions.

Table 8-Effect of pH on Spreading Properties Vs. Time

Time	Product	Spread Diameter (mm)			
		pH 3	pH 4	pH 5	pH 10
0h	A	34	28	29	27
1h	A	39	37	27	33
2h	A	36	30	33	33
4h	A	41	28	28	29
6h	A	16	27	27	28
8h	A	12	31	29	27
24h	A	12	32	25	25
48h	A	10	41	25	33
5 days	A	7	30	26	36
7 days	A	6	17	28	25
14 days	A	7	7	37	15

[0063] Table 9 is an illustrative example of an organomodified silylated surfactant of the present invention, where product No. 2, a superspreader, has improved resistance to hydrolysis, over a pH range from pH 3 to pH 10 relative to a traditional trisiloxane ethoxylate surfactant (Product A). As mentioned above, resistance to hydrolysis was observed by monitoring the spreading properties over time. Here a 0.1 wt% solution was prepared at pH 3, 4, 5 and 10. Spreading was determined by applying a 10  $\mu$ L droplet, of surfactant solution to polystyrene Petri dishes (Fisher Scientific) and measuring the spread diameter (mm) after 30 seconds, at a relative humidity between 50 and 70% (at 22 to 25°C). The solution was applied with an automatic pipette to provide droplets of reproducible volume. Deionized water that was further purified with a Millipore filtration system was used to prepare the surfactant solutions.

Table 9-Effect of pH on Spreading Properties Vs. Time

Time	Product	Spread Diameter (mm)			
		pH 3	pH 4	pH 5	pH 10
0h	2	39	39	41	27
24h	2	37	38	37	35
48h	2	39	39	36	38
72h	2	39	38	39	35
1 week	2	38	39	40	36
2 weeks	2	39	37	39	39
1 month	2	40	39	40	39
2 months	2	43	41	41	41
3 months	2	39	40	37	45
6 months	2	43	40	44	41
12 months	2	45	38	42	41

Example 8

[0064] The impact of other ingredients on spreading was determined by blending the organomodified silylated surfactant of the present invention, with a conventional organic based co-surfactant. The co-surfactants are described in Table 10.

[0065] Blends were prepared as physical mixtures where the weight fraction of the silylated surfactant is represented by  $\alpha$  (alpha), indicating that the co-surfactant makes up the balance of the blend ratio. For example when  $\alpha = 0$  this indicates that the composition contains 0% of the silylated surfactant component and 100% co-surfactant, while an  $\alpha = 1.0$  indicates the composition contains 100% silylated surfactant, and no (0%) co-surfactant. Mixtures of the two components are represented by the weight fraction  $\alpha$ , where  $\alpha$  ranges as follows:  $0 \leq \alpha \leq 1.0$ . By example when  $\alpha = 0.25$  this indicates the surfactant mixture is composed of 25% silylated surfactant and 75% co-surfactant. These

blends are then diluted in water to the desired concentration for spreading evaluation.

[0066] Spreading was determined as described in Example 5, at 0.1wt% total surfactant.

[0067] The silylated surfactant alone at relative concentrations (i.e.  $\alpha = 0.75$  is equivalent to 0.075% of this surfactant in water) was used as a baseline for spread performance, since the major contributor to spreading comes from the silylated surfactant. The maximum spreading provided by the co-surfactant at 0.1%. ( $\alpha = 0$ ). Synergy is demonstrated when the blend of silylated surfactant and co-surfactant exceeds the spreading of the co-surfactant ( $\alpha = 0$ ) and the silylated surfactant at the relative  $\alpha$  value.

[0068] Table 11 demonstrates that representative examples of the co-surfactants of the present invention provide favorable spreading results, and in some cases provide an unexpected synergistic enhancement, where the spread diameter of the mixture exceeds that of the individual components.

Table 10 - Description of Conventional Co-surfactants

ID	Description
PAO-20	Polyoxyethylene/polyoxypropylene copolymer (20% EO)
IDA-6	Isodecyl alcohol ethoxylate (5-6 EO)
Oxo-TDA-5	Oxo-tridecyl alcohol ethoxylate (5 EO)
APG	C <sub>8-10</sub> Alkylpolyglucoside

Table 11 - Effect of Co-surfactants on Blend Spreading Properties

Run	Silylated Surfactan	Wt Fraction ( $\alpha$ ) Silylated Surfactant					Co-surfactant
		Spread diameter (mm)					
		0	0.25	0.50	0.75	1.0	
1	2	6	21	32	40	44	PAO-20
2	2	8	26	35	40	44	IDA-6
3	2	24	41	43	45	44	Oxo-TDA-5
4	2	7	21	35	38	44	APG
5	2	NA	13	26	34	44	None <sup>a</sup>

a. Silylated Surfactant 2 alone at relative concentration (i.e.  $\alpha = 0.25$  is 0.025% product 2).

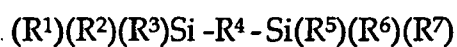
[0069] The foregoing examples are merely illustrative of the invention, serving to illustrate only some of the features of the present invention. The appended claims are intended to claim the invention as broadly as it has been conceived and the examples herein presented are illustrative of selected embodiments from a manifold of all possible embodiments. Accordingly it is the Applicants' intention that the appended claims are not to be limited by the choice of examples utilized to illustrate features of the present invention. As used in the claims, the word "comprises" and its grammatical variants logically also subtend and include phrases of varying and differing extent such as for example, but not limited thereto, "consisting essentially of" and "consisting of." Where necessary, ranges have been supplied, those ranges are inclusive of all sub-ranges there between. Such ranges may be viewed as a Markush group or groups consisting of differing pairwise numerical limitations which group or groups is or are fully

defined by its lower and upper bounds, increasing in a regular fashion numerically from lower bounds to upper bounds. It is to be expected that variations in these ranges will suggest themselves to a practitioner having ordinary skill in the art and where not already dedicated to the public, those variations should where possible be construed to be covered by the appended claims. It is also anticipated that advances in science and technology will make equivalents and substitutions possible that are not now contemplated by reason of the imprecision of language and these variations should also be construed where possible to be covered by the appended claims. All United States patents (and patent applications) referenced herein are herewith and hereby specifically incorporated by reference in their entirety as though set forth in full.

## CLAIMS

Having described the invention we claim:

1. A composition comprising a silicon containing compound having the formula:



wherein

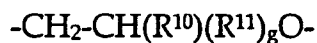
$R^1$ ,  $R^2$ ,  $R^3$ ,  $R^5$ , and  $R^6$  are each independently selected from the group consisting of 1 to 6 monovalent hydrocarbon radicals, aryl, and a hydrocarbon group of 7 to 10 carbons containing an aryl group;

$R^4$  is a hydrocarbon group of 1 to 3 carbons;

$R^7$  is an alkyleneoxide group of the general formula:



where  $R^8$  is a divalent linear or branched hydrocarbon radical having the structure:



where  $R^{10}$  is H or methyl;

$R^{11}$  is a divalent alkyl radical of 1 to 6 carbons where the subscript  $g$  is 0 or 1;

R<sup>9</sup> is selected from the group consisting of H, monovalent hydrocarbon radicals of 1 to 6 carbon atoms and acetyl, subject to the limitation that the subscripts d, e and f are zero or positive and satisfy the following relationships:

$$2 \leq d + e + f \leq 20 \text{ with } d \geq 2.$$

2. The composition of claim 1 where R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>5</sup>, and R<sup>6</sup> are methyl.
3. The composition of claim 2 where R<sup>10</sup> is hydrogen.
4. The composition of claim 3 where the subscript g is zero.
5. The composition of claim 3 where the subscript g is one.
6. The composition of claim 5 where R<sup>11</sup> is -CH<sub>2</sub>-.
7. The composition of claim 5 where R<sup>11</sup> is a divalent alkyl radical of 2 carbons
8. The composition of claim 2 where R<sup>10</sup> is methyl.
9. The composition of claim 8 where the subscript g is zero.
10. The composition of claim 8 where the subscript g is one.
11. The composition of claim 10 where R<sup>11</sup> is -CH<sub>2</sub>-.
12. The composition of claim 10 where R<sup>11</sup> is a divalent alkyl radical of 2 carbons.
13. A composition comprising a silicon containing compound having the formula:



wherein

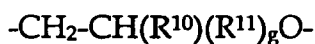
$R^1$ ,  $R^2$ ,  $R^3$ ,  $R^5$ , and  $R^6$  are each independently selected from the group consisting of 1 to 6 monovalent hydrocarbon radicals, aryl, and a hydrocarbon group of 7 to 10 carbons containing an aryl group;

$R^4$  is a hydrocarbon group of 1 to 3 carbons;

$R^7$  is an alkyleneoxide group of the general formula:



where  $R^8$  is a divalent linear or branched hydrocarbon radical having the structure:



where  $R^{10}$  is H or methyl;

$R^{11}$  is a divalent alkyl radical of 1 to 6 carbons where the subscript  $g$  is 0 or 1;

$R^9$  is selected from the group consisting of H, monovalent hydrocarbon radicals of 1 to 6 carbon atoms and acetyl, subject to the limitation that the subscripts  $d$ ,  $e$  and  $f$  are zero or positive and satisfy the following relationships:

$$2 \leq d + e + f \leq 20 \text{ with } d \geq 2$$

wherein said silicon containing compound is resistant to hydrolysis.

14. The composition of claim 13 where  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^5$ , and  $R^6$  are methyl.

15. The composition of claim 14 where R<sup>10</sup> is hydrogen.
16. The composition of claim 15 where the subscript g is zero.
17. The composition of claim 15 where the subscript g is one.
18. The composition of claim 17 where R<sup>11</sup> is -CH<sub>2</sub>-.
19. The composition of claim 17 where R<sup>11</sup> is a divalent alkyl radical of 2 carbons.
20. The composition of claim 13 where R<sup>10</sup> is methyl.
21. The composition of claim 20 where the subscript g is zero.
22. The composition of claim 20 where the subscript g is one.
23. The composition of claim 22 where R<sup>11</sup> is -CH<sub>2</sub>-.
24. The composition of claim 22 where R<sup>11</sup> is a divalent alkyl radical of 2 carbons.
25. A silane compound having the formula:



wherein

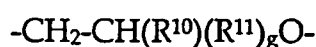
R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>5</sup>, and R<sup>6</sup> are each independently selected from the group consisting of 1 to 6 monovalent hydrocarbon radicals, aryl, and a hydrocarbon group of 7 to 10 carbons containing an aryl group;

R<sup>4</sup> is a hydrocarbon group of 1 to 3 carbons;

$R^7$  is an alkyleneoxide group of the general formula:



where  $R^8$  is a divalent linear or branched hydrocarbon radical having the structure:



where  $R^{10}$  is H or methyl;

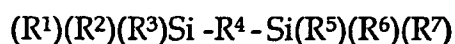
$R^{11}$  is a divalent alkyl radical of 1 to 6 carbons where the subscript  $g$  is 0 or 1;

$R^9$  is selected from the group consisting of H, monovalent hydrocarbon radicals of 1 to 6 carbon atoms and acetyl, subject to the limitation that the subscripts  $d$ ,  $e$  and  $f$  are zero or positive and satisfy the following relationships:

$$2 \leq d + e + f \leq 20 \text{ with } d \geq 2.$$

26. The composition of claim 25 where  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^5$ , and  $R^6$  are methyl.
27. The composition of claim 26 where  $R^{10}$  is hydrogen.
28. The composition of claim 27 where the subscript  $g$  is zero.
29. The composition of claim 27 where the subscript  $g$  is one.
30. The composition of claim 29 where  $R^{11}$  is  $-CH_2-I$ .
31. The composition of claim 29 where  $R^{11}$  is a divalent alkyl radical of 2 carbons.

32. The composition of claim 26 where R<sup>10</sup> is methyl.
33. The composition of claim 32 where the subscript g is zero.
34. The composition of claim 32 where the subscript g is one.
35. The composition of claim 34 where R<sup>11</sup> is -CH<sub>2</sub>-.
36. The composition of claim 34 where R<sup>11</sup> is a divalent alkyl radical of 2 carbons.
37. A silane compound having the formula:

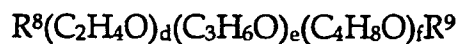


wherein

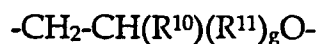
R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>5</sup>, and R<sup>6</sup> are each independently selected from the group consisting of 1 to 6 monovalent hydrocarbon radicals, aryl, and a hydrocarbon group of 7 to 10 carbons containing an aryl group;

R<sup>4</sup> is a hydrocarbon group of 1 to 3 carbons;

R<sup>7</sup> is an alkyleneoxide group of the general formula:



where R<sup>8</sup> is a divalent linear or branched hydrocarbon radical having the structure:



where R<sup>10</sup> is H or methyl;

R<sup>11</sup> is a divalent alkyl radical of 1 to 6 carbons where the subscript g is 0 or 1;

R<sup>9</sup> is selected from the group consisting of H, monovalent hydrocarbon radicals of 1 to 6 carbon atoms and acetyl, subject to the limitation that the subscripts d, e and f are zero or positive and satisfy the following relationships:

$2 \leq d + e + f \leq 20$  with  $d \geq 2$ , wherein said silane compound is resistant to hydrolysis.

38. The composition of claim 37 where R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>5</sup>, and R<sup>6</sup> are methyl.
39. The composition of claim 38 where R<sup>10</sup> is hydrogen.
40. The composition of claim 39 where the subscript g is zero.
41. The composition of claim 39 where the subscript g is one.
42. The composition of claim 41 where R<sup>11</sup> is -CH<sub>2</sub>-.
43. The composition of claim 41 where R<sup>11</sup> is a divalent alkyl radical of 2 carbons.
44. The composition of claim 38 where R<sup>10</sup> is methyl.
45. The composition of claim 44 where the subscript g is zero.
46. The composition of claim 44 where the subscript g is one.
47. The composition of claim 46 where R<sup>11</sup> is -CH<sub>2</sub>-.

48. The composition of claim 46 where R<sup>11</sup> is a divalent alkyl radical of 2 carbons.

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2007/007904

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. C07F/08 C08G65/336 C08G77/48

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
 C07F C08G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)  
 EPO-Internal, WPI Data, CHEM ABS Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 44 33 139 A1 (THERA GES FUER PATENTE [DE]) 21 March 1996 (1996-03-21) page 2, lines 24-26 page 4, line 19; claims	1-48
X	MAKI H ET AL: "SYNTHESES AND PROPERTIES OF SURFACTANTS CONTAINING ORGANOMETALS: IVORGANO SILICON" JOURNAL OF THE AMERICAN OIL CHEMISTS' SOCIETY, AOCs PRESS, CHAMPAIGN, IL, US, vol. 46, no. 12, 1969, pages 635-638, XP000882184 ISSN: 0003-021X page 636, upper right quarter figure 4; table II	1-48
	----- -/--	

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*Z\* document member of the same patent family

Date of the actual completion of the international search  <b>3 September 2007</b>	Date of mailing of the international search report  <b>12/09/2007</b>
--	---

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer  <b>Hein, Friedrich</b>
---	--

## INTERNATIONAL SEARCH REPORT

 International application No  
 PCT/US2007/007904

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	R. WAGNER ET AL.: "Silicon-Modified Carbohydrate Surfactants V: Wetting Behaviour of Low-Molecular-Weight Siloxane, Carbosilane, Silane and Polysilane Precursors on Low-Energy Surfaces" APPLIED ORGANOMETALLIC CHEMISTRY, vol. 11, 1997, pages 645-657, XP002445519 tables 2,3	1-48
A	----- GB 1 520 421 A (DOW CORNING LTD) 9 August 1978 (1978-08-09) page 2, lines 38-45; claims	1-48
A	----- DE 43 20 920 C1 (GOLDSCHMIDT AG TH [DE]) 16 June 1994 (1994-06-16) claims	1-48
A	----- EP 0 367 381 A (DOW CORNING [GB]) 9 May 1990 (1990-05-09) claims	1-48
A	----- US 3 299 112 A (BAILEY DONALD L) 17 January 1967 (1967-01-17) column 1, lines 11-14 column 2, line 7 column 3, lines 15-23	1-48
A	----- US 6 211 284 B1 (ISHIKAWA HIROKI [JP] ET AL) 3 April 2001 (2001-04-03) column 1, lines 30-4,48-51; claims	1-48
E	----- WO 2007/044552 A (GEN ELECTRIC [US]; LEATHERMAN MARK D [US]; POLICELLO GEORGE A [US]; RA) 19 April 2007 (2007-04-19) pages 7-15; claims	1-48

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2007/007904

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4433139	A1	21-03-1996	AT 191334 T 15-04-2000
			AU 698620 B2 05-11-1998
			AU 3607195 A 29-03-1996
			WO 9608230 A1 21-03-1996
			EP 0729341 A1 04-09-1996
			ES 2144633 T3 16-06-2000
			JP 9505322 T 27-05-1997
			US 5750589 A 12-05-1998
GB 1520421	A	09-08-1978	NONE
DE 4320920	C1	16-06-1994	AU 668041 B2 18-04-1996
			AU 6475294 A 05-01-1995
			AU 667436 B2 21-03-1996
			AU 6475394 A 05-01-1995
			BR 9402516 A 14-03-1995
			BR 9402517 A 14-03-1995
			CA 2124876 A1 25-12-1994
			CA 2124877 A1 25-12-1994
			CN 1106413 A 09-08-1995
			CN 1107477 A 30-08-1995
			DK 630901 T3 30-08-1999
			DK 630902 T3 30-08-1999
			EP 0630901 A1 28-12-1994
			EP 0630902 A1 28-12-1994
			ES 2128460 T3 16-05-1999
			ES 2128461 T3 16-05-1999
			JP 2749520 B2 13-05-1998
			JP 7010884 A 13-01-1995
			JP 7033782 A 03-02-1995
			MX 9404815 A1 31-01-1995
			MX 9404816 A1 31-01-1995
			NZ 260770 A 21-12-1995
			NZ 260771 A 21-12-1995
US 5430167 A 04-07-1995			
US 5430166 A 04-07-1995			
EP 0367381	A	09-05-1990	CA 1332244 C 04-10-1994
			JP 2104592 A 17-04-1990
			US 5026891 A 25-06-1991
US 3299112	A	17-01-1967	BE 665645 A 18-10-1965
			DE 1493380 A1 30-01-1969
			GB 1121831 A 31-07-1968
			NL 133334 C
			NL 6507928 A 20-12-1965
US 6211284	B1	03-04-2001	JP 2000017177 A 18-01-2000
WO 2007044552	A	19-04-2007	US 2007086968 A1 19-04-2007