[0006] Accordingly, in a first aspect, the composition includes a mixture or solution of: acetylene; and a stabilizer including a ketone having a vapor pressure of about 30 Torr or lower at 25° C. In particular embodiments, the acetylene and stabilizer are stored in a containment vessel.

[0007] In a second aspect, the composition includes a mixture or solution of: acetylene; and a stabilizer including a ketone. In some embodiments, the ketone is selected from acetylacetone (acac), 2-butanone, 2-pentanone, 2-hexanone, 2-heptanone, 2-octanone, 2-nonanone, 2-decanone, 3-pentanone, 3-heptanone, 3-octanone, 3-nonanone, 3-decanone, and aromatic ~~aldehydes~~ketones such as acetophenone, 3-hydroxyacetophenone, cyclohexanone, benzophenone, butyrophenone, acetylpyrazine, 2-acetyl pyridine, acrylophenone, capillin, dibenzoylmethane, indenone, 1-indanone, paroxypropione, phenylglyoxal, piceol, propriophenone, pyridoxal, 2,4,6-trihydroxyacetophenone, 2,4,5-trihydroxyacetophenone, and valerophenone, as well as mixtures thereof. In particular embodiments, the acetylene and stabilizer are stored in a containment vessel.

[0008] In a third aspect, the composition includes a mixture or solution of: acetylene; and a stabilizer including an ionic liquid (e.g., any described herein, such as an ionic liquid including one or more cationic moieties and one or more anionic moieties). Exemplary, non-limiting ionic liquids include a cation selected from imidazolium, pyridinium, ammonium, phosphonium, thiazolium, and triazolium. In particular embodiments, the acetylene and stabilizer are stored in a containment vessel.

[0009] In a fourth aspect, the composition includes a mixture or solution of: acetylene; and a stabilizer selected from carbenes and silylenes. In one embodiment, the stabilizer is a carbene selected from transition metal carbene complexes, *N*-heterocyclic carbenes, and methylenes. In other embodiments, the stabilizer is a silylene (e.g., an *N*-heterocyclic silylene). In particular embodiments, the acetylene and stabilizer are stored in a containment vessel.

[0010] In a fifth aspect, the composition includes a mixture or solution of: acetylene; and a stabilizer including an aldehyde (e.g., any described herein). In some embodiments, the stabilizer is benzaldehyde. In particular embodiments, the acetylene and stabilizer are stored in a containment vessel.

[0011] In a sixth aspect, the composition includes a mixture or solution of: acetylene; and a stabilizer including an ester having a vapor pressure of about 90 Torr or lower at 25° C. In particular embodiments, the acetylene and stabilizer are stored in a containment vessel.

Examples of organic carbonyl compounds include ketones, aldehydes, carboxylic acids, esters, and amides.

[0057] Suitable acetylene stabilizing ketones may have the general formula XYC=O. In certain embodiments, X is the same as Y. In certain embodiments, X and Y are not the same. In certain embodiments, each X and/or Y is independently selected from hydrogen, aliphatic, aryl, heteroaliphatic, or heteroaryl. Exemplary alkyl group includes, but are not limited to, methyl, ethyl, propyl, butyl, isopropyl, and t-butyl. In certain embodiments, aryl rings of the aryl ketones are substituted at the 1, 2, and/or 3 positions; and the aryl rings can be substituted with one or more functional groups selected from aliphatic, alkoxy, amide, amine, thioether, haloalkyl, nitro, halo, silyl, cycloaliphatic, aryl, and the like.

[0058] Examples of ketones that may serve as acetylene stabilizers include acetylacetone (acac), 2-butanone, 2-pentanone, 2-hexanone, 2-heptanone, 2-octanone, 2-nonanone, 2-decanone, 3-pentanone, 3-heptanone, 3-octanone, 3-nonanone, 3-decanone, and aromatic ~~aldehydes~~ketones such as acetophenone, 3-hydroxyacetophenone, cyclohexanone, benzophenone, butyrophenone, acetylpyrazine, 2-acetyl pyridine, acrylophenone, capillin, dibenzoylmethane, indenone, 1-indanone, paroxypropione, phenylglyoxal, piceol, propriophenone, pyridoxal, 2,4,6-trihydroxyacetophenone, 2,4,5-trihydroxyacetophenone, and valerophenone. In certain embodiments, the ketone stabilizer has a vapor pressure of about 700 Torr or lower at 25° C. In certain embodiments, the ketone stabilizer has a vapor pressure of about 30 Torr or lower at 25° C.

[0059] An example aldehyde that may serve as acetylene stabilizers is benzaldehyde. In certain embodiments, the aldehyde stabilizer has a vapor pressure of about 700 Torr or lower at 25° C. In certain embodiments, the aldehyde stabilizer has a vapor pressure of about 200 Torr or lower at 25° C.

[0060] Carboxylic acids may serve as acetylene stabilizers. In certain embodiments, the carboxylic acid stabilizer has a vapor pressure of about 700 Torr or lower at 25° C. In certain embodiments, the carboxylic acid stabilizer has a vapor pressure of about 15 Torr or lower at 25° C.

[0061] Esters may serve as acetylene stabilizers. In certain embodiments, the ester stabilizer has a vapor pressure of about 700 Torr or lower at 25° C. In certain embodiments, the ester stabilizer has a vapor pressure of about 90 Torr or lower at 25° C.

carbons and an alkoxy group with 1 to 6 carbons (i.e., C_{1-6} alkoxy-C_{1-6} alkyl). In some embodiments, the alkoxyalkyl group is -L-O-R, in which each of L and R is, independently, an alkyl group, as defined herein.

[0093] By "alkyl" is meant a saturated monovalent hydrocarbon having at least one carbon atom to 50 carbon atoms (C_{1-50}), such as one to 25 carbon atoms (C_{1-25}), or one to ten carbon atoms (C_{1-10}), wherein the saturated monovalent hydrocarbon can be derived from removing one hydrogen atom from one carbon atom of a parent compound (e.g., alkane). An alkyl group can be branched, straight-chain, or cyclic (e.g., cycloalkyl). An exemplary alkyl includes a branched or unbranched saturated hydrocarbon group of 1 to 24 carbon atoms, such as methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, s-butyl, t-butyl, n-pentyl, isopentyl, s-pentyl, neopentyl, hexyl, heptyl, octyl, nonyl, decyl, dodecyl, tetradecyl, hexadecyl, eicosyl, tetracosyl, and the like. The alkyl group can also be substituted or unsubstituted. The alkyl group can be monovalent or multivalent (e.g., bivalent) by removing one or more hydrogens to form appropriate attachment to the parent molecular group or appropriate attachment between the parent molecular group and another substitution. For example, the alkyl group can be substituted with one, two, three or, in the case of alkyl groups of two carbons or more, four substituents independently selected from the group consisting of: (1) C_{1-6} alkoxy (e.g., -O-R, in which R is C_{1-6} alkyl); (2) C_{1-6} alkylsulfinyl (e.g., -S(O)-R, in which R is C_{1-6} alkyl); (3) C_{1-6} alkylsulfonyl (e.g., -SO_2-R, in which R is C_{1-6} alkyl); (4) amine (e.g., -$C(O)NR^1R^2$ or -$NHCOR^1$, where each of R^1 and R^2 is, independently, selected from hydrogen, aliphatic, heteroaliphatic, haloaliphatic, haloheteroaliphatic, aromatic, as defined herein, or any combination thereof, or R^1 and R^2, taken together with the nitrogen atom to which each are attached, can form a heterocyclyl group, as defined herein); (5) aryl; (6) arylalkoxy (e.g., -O-L-R, in which L is alkyl and R is aryl); (7) aryloyl (e.g., -C(O)-R, in which R is aryl); (8) azido (e.g., -N_3); (9) cyano (e.g., -CN); (10) aldehyde (e.g., -C(O)H); (11) C_{3-8} cycloalkyl; (12) halo; (13) heterocyclyl (e.g., as defined herein, such as a 5-, 6- or 7-membered ring containing one, two, three, or four non-carbon heteroatoms); (14) heterocyclyloxy (e.g., -O-R, in which R is heterocyclyl, as defined herein); (15) heterocyclyloyl (e.g., -C(O)-R, in which R is heterocyclyl, as defined herein); (16) hydroxyl (e.g., -OH); (17) *N*-protected amino; (18) nitro (e.g., -NO_2); (19) oxo (e.g., =O); (20) C_{1-6} ~~thioalkoxy~~thioalkyl (e.g., -S-R, in which R is alkyl); (21) thiol (e.g., -SH); (22) -CO_2R^1, where R^1 is selected from the group consisting of (a) hydrogen, (b) C_{1-6} alkyl, (c) C_{4-18} aryl, and (d) C_{1-6} alkyl-C_{4-18} aryl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{4-18} aryl); (23) -$C(O)NR^1R^2$, where each of R^1 and R^2 is, independently, selected from

alkyl); (4) C_{1-6} alkoxy-C_{1-6} alkyl (e.g., -L-O-R, in which each of L and R is, independently, C_{1-6} alkyl); (5) C_{1-6} alkylsulfinyl (e.g., -S(O)-R, in which R is C_{1-6} alkyl); (6) C_{1-6} alkylsulfinyl-C_{1-6} alkyl (e.g., -L-S(O)-R, in which each of L and R is, independently, C_{1-6} alkyl); (7) C_{1-6} alkylsulfonyl (e.g., -SO_2-R, in which R is C_{1-6} alkyl); (8) C_{1-6} alkylsulfonyl-C_{1-6} alkyl (e.g., -L-SO_2-R, in which each of L and R is, independently, C_{1-6} alkyl); (9) aryl; (10) amine (e.g., -NR^1R^2, where each of R^1 and R^2 is, independently, selected from hydrogen, aliphatic, heteroaliphatic, haloaliphatic, haloheteroaliphatic, aromatic, as defined herein, or any combination thereof; or R^1 and R^2, taken together with the nitrogen atom to which each are attached, can form a heterocyclyl group, as defined herein); (11) C_{1-6} aminoalkyl (e.g., -L^1-NR^1R^2 or -L^2-$C(NR^1R^2)(R^3)$-R^4, in which L^1 is C_{1-6} alkyl; L^2 is a covalent bond or C_{1-6} alkyl; each of R^1 and R^2 is, independently, selected from hydrogen, aliphatic, heteroaliphatic, haloaliphatic, haloheteroaliphatic, aromatic, as defined herein, or any combination thereof; or R^1 and R^2, taken together with the nitrogen atom to which each are attached, can form a heterocyclyl group, as defined herein; and each of R^3 and R^4 is, independently, H or C_{1-6} alkyl); (12) heteroaryl; (13) C_{1-6} alkyl-C_{4-18} aryl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{4-18} aryl); (14) aryloyl (e.g., -C(O)-R, in which R is aryl); (15) azido (e.g., -N_3); (16) cyano (e.g., -CN); (17) C_{1-6} azidoalkyl (e.g., -L-N_3, in which L is C_{1-6} alkyl); (18) aldehyde (e.g., -C(O)H); (19) aldehyde-C_{1-6} alkyl (e.g., -L-C(O)H, in which L is C_{1-6} alkyl); (20) C_{3-8} cycloalkyl; (21) C_{1-6} alkyl-C_{3-8} cycloalkyl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{3-8} cycloalkyl); (22) halo; (23) C_{1-6} haloalkyl (e.g., -L^1-X or -L^2-$C(X)(R^1)$-R^2, in which L^1 is C_{1-6} alkyl; L^2 is a covalent bond or C_{1-6} alkyl; X is fluoro, bromo, chloro, or iodo; and each of R^1 and R^2 is, independently, H or C_{1-6} alkyl); (24) heterocyclyl (e.g., as defined herein, such as a 5-, 6- or 7-membered ring containing one, two, three, or four non-carbon heteroatoms); (25) heterocyclyloxy (e.g., -O-R, in which R is heterocyclyl, as defined herein); (26) heterocyclyloyl (e.g., -C(O)-R, in which R is heterocyclyl, as defined herein); (27) hydroxyl (-OH); (28) C_{1-6} hydroxyalkyl (e.g., -L^1-OH or -L^2-$C(OH)(R^1)$-R^2, in which L^1 is C_{1-6} alkyl; L^2 is a covalent bond or alkyl; and each of R^1 and R^2 is, independently, H or C_{1-6} alkyl, as defined herein); (29) nitro; (30) C_{1-6} nitroalkyl (e.g., -L^1-NO or -L^2-$C(NO)(R^1)$-R^2, in which L^1 is C_{1-6} alkyl; L^2 is a covalent bond or alkyl; and each of R^1 and R^2 is, independently, H or C_{1-6} alkyl, as defined herein); (31) *N*-protected amino; (32) *N*-protected amino-C_{1-6} alkyl; (33) oxo (e.g., =O); (34) C_{1-6} ~~thioalkoxy~~thioalkyl (e.g., -S-R, in which R is C_{1-6} alkyl); (35) thio-C_{1-6} alkoxy-C_{1-6} alkyl (e.g., -L-S-R, in which each of L and R is, independently, C_{1-6} alkyl); (36) -$(CH_2)_rCO_2R^1$, where r is an integer of from zero to four, and R^1 is selected from the group consisting of (a) hydrogen, (b)

[0154] By "silyl ether" is meant a functional group including a silicon atom covalently bound to an alkoxy group, as defined herein. In some embodiments, the silyl ether is -Si-O-R or Si-O-R, in which R is an alkyl group, as defined herein.

[0155] By "sulfinyl" is meant an -S(O)- group.

[0156] By "sulfo" is meant an $-S(O)_2OH$ group.

[0157] By "sulfonyl" or "sulfonate" is meant an $-S(O)_2-$ group or a $-SO_2R$, where R is selected from hydrogen, aliphatic, heteroaliphatic, haloaliphatic, haloheteroaliphatic, aromatic, as defined herein, or any combination thereof.

[0158] By "~~thioalkoxy~~thioalkyl" is meant an alkyl group, as defined herein, attached to the parent molecular group through a sulfur atom. Exemplary unsubstituted ~~thioalkoxy~~thioalkyl groups include C_{1-6} ~~thioalkoxy~~thioalkyl. In some embodiments, the ~~thioalkoxy~~thioalkyl group is -S-R, in which R is an alkyl group, as defined herein.

[0159] By "~~thioalkoxyalkyl~~thioalkylalkyl" is meant an alkyl group, as defined herein, which is substituted with a ~~thioalkoxy~~thioalkyl group, as defined herein. Exemplary unsubstituted ~~thioalkoxyalkyl~~thioalkylalkyl groups include between 2 to 12 carbons (C_{2-12} ~~thioalkoxyalkyl~~thioalkylalkyl), as well as those having an alkyl group with 1 to 6 carbons and a ~~thioalkoxy~~thioalkyl group with 1 to 6 carbons (i.e., C_{1-6} ~~thioalkoxy~~thioalkyl-C_{1-6} alkyl). In some embodiments, the ~~thioalkoxyalkyl~~thioalkylalkyl group is -L-S-R, in which each of L and R is, independently, an alkyl group, as defined herein.

[0160] By "thiol" is meant an -SH group.

[0161] A person of ordinary skill in the art would recognize that the definitions provided above are not intended to include impermissible substitution patterns (e.g., methyl substituted with 5 different groups, and the like). Such impermissible substitution patterns are easily recognized by a person of ordinary skill in the art. Any functional group disclosed herein and/or defined above can be substituted or unsubstituted, unless otherwise indicated therein.

Acids

[0162] In one embodiment, the stabilizer is an acid having a formula $R-CO_2H$ wherein R is selected from hydrogen, aliphatic, haloaliphatic, haloheteroaliphatic, heteroaliphatic, aromatic, aliphatic-aromatic, heteroaliphatic-aromatic or any combinations thereof. In certain embodiments, R is alkyl, alkenyl, alkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, haloalkyl, haloalkenyl, haloalkynyl, haloheteroalkyl, haloheteroalkenyl, haloheteroalkynyl, aryl, heteroaryl, alkyl-aryl, alkenyl-aryl, alkynyl-aryl, alkyl-heteroaryl, alkenyl-heteroaryl, alkynyl-heteroaryl, heteroalkyl-aryl, heteroalkenyl-aryl, heteroalkynyl-aryl, heteroalkyl-heteroaryl, heteroalkenyl-heteroaryl, heteroalkynyl-heteroaryl or any combinations thereof. In particular

butadiene, an optionally substituted cyclopentadiene, an optionally substituted o-quinodimethane, and an optionally substituted 1,2-dihydropyridine.

Esters

[0217] The stabilizer can be an ester having a formula of X-$[O]_n$-C(O)-O-Y, where:

n is 0 or 1;

each X and Y can be independently selected from -$[C(R^1)_2]_m$-$C(R^1)$ or -$\{[C(R^1)_2]_m$-$[O]_n\}_p$-$C(R^1)$ or -$[C(R^1)_2]_m$-C(O)-$N(R^1)_2$ or -$[C(R^1)_2]_m$-C(O)-O-$[C(R^1)_2]_m$-$C(R^1)$, wherein each R^1 is independently selected from hydrogen, hydroxyl, aliphatic, haloaliphatic, haloheteroaliphatic, heteroaliphatic, aromatic, aliphatic-aromatic, heteroaliphatic-aromatic, or any combinations thereof, and wherein *m* is an integer from 0 to 10 and *p* is an integer from 1 to 10; and

in which X and Y, taken together with the atom to which each are attached, can optionally form a cycloheteroaliphatic group.

[0218] In some embodiments, each R^1 independently is selected from alkyl, alkenyl, alkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, haloalkyl, haloalkenyl, haloalkynyl, haloheteroalkyl, haloheteroalkenyl, haloheteroalkynyl, aryl, heterocyclyl, heteroaryl, alkyl-aryl, alkenyl-aryl, alkynyl-aryl, alkyl-heterocyclyl, alkenyl-heterocyclyl, alkynyl-heterocyclyl, alkyl-heteroaryl, alkenyl-heteroaryl, alkynyl-heteroaryl, heteroalkyl-aryl, heteroalkenyl-aryl, heteroalkynyl-aryl, heteroalkyl-heterocyclyl, heteroalkenyl-heterocyclyl, heteroalkynyl-heterocyclyl, heteroalkyl-heteroaryl, heteroalkenyl-heteroaryl, heteroalkynyl-heteroaryl, or any combinations thereof. In particular disclosed embodiments, the ester may further be substituted with one or more substituents, such as alkoxy, amide, amine, thioether, thiol, acyloxy, silyl, cycloaliphatic, aryl, aldehyde, ketone, ester, carboxylic acid, acyl, acyl halide, cyano, halogen, sulfonate, nitro, nitroso, quaternary amine, pyridinyl (or pyridinyl, wherein the nitrogen atom is functionalized with an aliphatic or aryl group), alkyl halide, or any combinations thereof.

[0219] In some embodiments, when X and Y are taken together with the atom to which each are attached in order to form a cycloheteroaliphatic group, the stabilizer can be a cyclic ~~ether~~ester. Exemplary cyclic ~~ethers~~ester include lactones, such as ε-caprolactone, γ-caprolactone, γ-valerolactone, δ-valerolactone, and the like.

[0220] In some embodiments, when at least one of X or Y is -$[C(R^1)_2]_m$-C(O)-$N(R^1)_2$, then the ester can be an aminoester. Exemplary amino esters include methyl-5-(dimethylamino)-2-methyl-5-oxopentanoate and the like.

Ether	anisole	3.54	Aryl ether
Ether	dimethyl isosorbide	0.073	Cyclic ether
Ketone	methyl isobutyl ketone	19.9	
Ketone	diacetyl	56.8	Diketone

[0254] Any of the stabilizers described herein include unsubstituted and/or substituted forms of the compound. Non-limiting exemplary substituents include, e.g., one, two, three, four, or more substituents independently selected from the group consisting of: (1) C_{1-6} alkoxy (e.g., -O-R, in which R is C_{1-6} alkyl); (2) C_{1-6} alkylsulfinyl (e.g., -S(O)-R, in which R is C_{1-6} alkyl); (3) C_{1-6} alkylsulfonyl (e.g., -SO_2-R, in which R is C_{1-6} alkyl); (4) amine (e.g., -C(O)NR^1R^2 or -$NHCOR^1$, where each of R^1 and R^2 is, independently, selected from hydrogen, aliphatic, heteroaliphatic, haloaliphatic, haloheteroaliphatic, aromatic, as defined herein, or any combination thereof; or R^1 and R^2, taken together with the nitrogen atom to which each are attached, can form a heterocyclyl group, as defined herein); (5) aryl; (6) arylalkoxy (e.g., -O-L-R, in which L is alkyl and R is aryl); (7) aryloyl (e.g., -C(O)-R, in which R is aryl); (8) azido (e.g., -N_3); (9) cyano (e.g., -CN); (10) aldehyde (e.g., -C(O)H); (11) C_{3-8} cycloalkyl; (12) halo; (13) heterocyclyl (e.g., as defined herein, such as a 5-, 6- or 7-membered ring containing one, two, three, or four non-carbon heteroatoms); (14) heterocyclyloxy (e.g., -O-R, in which R is heterocyclyl, as defined herein); (15) heterocyclyloyl (e.g., -C(O)-R, in which R is heterocyclyl, as defined herein); (16) hydroxyl (e.g., -OH); (17) *N*-protected amino; (18) nitro (e.g., -NO_2); (19) oxo (e.g., =O); (20) C_{1-6} ~~thioalkoxy~~thioalkyl (e.g., -S-R, in which R is C_{1-6} alkyl); (21) thiol (e.g., -SH); (22) -CO_2R^1, where R^1 is selected from the group consisting of (a) hydrogen, (b) C_{1-6} alkyl, (c) C_{4-18} aryl, and (d) C_{1-6} alkyl-C_{4-18} aryl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{4-18} aryl); (23) -C(O)NR^1R^2, where each of R^1 and R^2 is, independently, selected from the group consisting of (a) hydrogen, (b) C_{1-6} alkyl, (c) C_{4-18} aryl, and (d) C_{1-6} alkyl-C_{4-18} aryl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{4-18} aryl); (24) -SO_2R^1, where R^1 is selected from the group consisting of (a) C_{1-6} alkyl, (b) C_{4-18} aryl, and (c) C_{1-6} alkyl-C_{4-18} aryl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{4-18} aryl); (25) -$SO_2NR^1R^2$, where each of R^1 and R^2 is, independently, selected from the group consisting of (a) hydrogen, (b) C_{1-6} alkyl, (c) C_{4-18} aryl, and (d) C_{1-6} alkyl-C_{4-18} aryl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{4-18} aryl); and (26) -NR^1R^2, where each of R^1 and R^2 is, independently, selected from the group consisting of (a) hydrogen, (b) an *N*-protecting group, (c) C_{1-6} alkyl, (d) C_{2-6} alkenyl, (e) C_{2-6} alkynyl, (f) C_{4-18} aryl, (g) C_{1-6} alkyl-C_{4-18} aryl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{4-18} aryl), (h) C_{3-8} cycloalkyl, and (i) C_{1-6} alkyl-C_{3-8} cycloalkyl (e.g., -L-R, in which L is C_{1-6} alkyl and R is C_{3-8} cycloalkyl), wherein in one

deposition chambers are usually operated at low pressures, 15 psig or less is a sufficiently high driving pressure to flow an acetylene gas stream through a pre-process module and into a deposition chamber. As an example, a deposition process may employ a flow rate of about 6750 sccm (6.75 L/min) while the deposition chamber is maintained at about 8 Torr. As discussed above, flow rates and chamber pressures may vary depending on process requirements.

[0259] In certain embodiments, the acetylene source is a cylinder that contains a filler material and stabilizer in addition to the safety relief devices. In certain embodiments, standard-sized hollow steel cylinders that are conventionally used for compressed gas service are used for acetylene. In certain embodiments, ganged cylinders, i.e., cylinders connected to a common gas line can be used.

[0260] While the acetylene source may be a bottle or cylinder, it may also be a tank or a facility wide supply of acetylene (e.g., an acetylene resource plumbed into the facility).

[0261] Fig. 2 is a block diagram depicting an example deposition system employing an acetylene source 202 and a deposition chamber 204, as well as other components. The acetylene canister or other acetylene source 202 has a corresponding pressure regulator 203 and is connected to the deposition chamber. The acetylene source contains acetylene and a stabilizer. In certain embodiments, the acetylene source is pressured to over about 200 psi.

[0262] When the acetylene gas stream is discharged from the acetylene source, it first passes through the pressure regulator 203 where the service pressure of the cylinder is reduced to a safe level below 15 psig. The acetylene is then passed via a processing line 206 and into the deposition chamber 204. Suitable materials for the processing line 206 include steel and wrought iron. Generally, cast iron, unalloyed copper, silver, or mercury are avoided because of possibility of forming explosive acetylides. The acetylene gas stream in the processing line may include some stabilizer vapor in addition to acetylene. The stabilizer concentration in the processing line may be in range of about 0.01% to 0.1% depending on the current service pressure of the acetylene cylinder. The temperature of the acetylene gas stream in the line depends on the storage conditions of the acetylene cylinder, evaporation rate and other factors. In certain embodiments, the stream may first be passed through a heat exchanger 207 to regulate the temperature of the acetylene during deposition. In certain embodiments, the heat exchanger 207 can maintain the temperature of the acetylene gas stream between about 10° C and 50° C. In some cases, the temperature is maintained between about 15° C and 30° C.

semiconductor substrate during fabrication of an electronic device. This process is performed in the deposition chamber 432.

[0286] Fig. 5 is a schematic diagram of a trap 500 used in an acetylene pre-processing module such as disclosed herein. With reference to Fig. 5, trap 500 may be an example of the element 412. The trap 500 includes a body 502 which includes a gas stream inlet line 504, a gas stream outlet line ~~504~~514, and a condensed liquid outlet 512. The gas stream inlet line 504 and the gas stream outlet line 504 may be attached to heat exchangers or other elements of the pre-processing module. The acetylene gas stream enters into the trap 500 through the inlet line 504. The stream has been already cooled before entering the trap and usually includes some liquid, such as condensed stabilizer with some dissolved acetylene. The liquid may be coming from the walls of the inlet line 504 or in the form of the mist, i.e., small droplets suspended in the acetylene gas stream. The trap 500 may include a mist barrier 506 that assists in separating the liquid from the acetylene gas stream. The mist barrier 506 could be made of any suitable material that is resistant to stabilizer and acetylene and can withstand temperatures (up to -80° C). In the certain embodiments, the mist barrier 506 is highly porous aluminum block (i.e. aluminum foam). The mist barrier 506 may have tortuous paths for the acetylene gas stream to pass through while trapping the liquid on the side of these paths. The liquid then flows back to the bottom of the trap 500. The porosity of the mist barrier 506 should be sufficiently open for the liquid to flow and not block the acetylene gas stream inside the trap. The mist trap 506 may also provide additional condensation surface for the stabilizer remaining in the acetylene gas stream.

[0287] As indicated, the condensed liquid gravitationally flows to the bottom of the trap 500. The liquid is then removed through the condensed liquid outlet 512. As explained with reference to Fig. 5, the removal of liquid may depend on a liquid level 510 at the bottom of the trap. When the liquid level 510 reaches a certain maximum value 510A, the draining valve of the pre-processing module is opened and the condensed liquid is drained through the condensed liquid outlet 512. Draining is then stopped when the liquid level 510 reaches or falls below a certain minimum value 510B. Monitoring of the liquid level 510 within the trap 500 is done through a sensor path 508 that provides a direct exposure of the liquid level to a liquid level sensor.

[0288] The acetylene gas stream then leaves the trap 500 through the gas ~~line~~stream outlet line 514. As explained above, the stream may then enter another heat exchanger where addition

condensation may occur. Any additional condensation the ~~outlet~~ gas stream outlet line 514 returns to the bottom of the trap 500.

Deposition chamber

[0289] The disclosed carbon deposition processes may be implemented in a plasma enhanced chemical vapor deposition (PECVD) reactor. Such a reactor may take many different forms. In certain embodiments, the apparatus will include one or more chambers or "reactors" (sometimes including multiple stations) that house one or more wafers and are suitable for wafer processing. During deposition, a chamber may hold one or more wafers for processing. The one or more chambers maintain the wafer in a defined position or positions during deposition. In one embodiment, a wafer undergoing hard mask deposition is transferred from one station to another within a reactor chamber during the process. For example, for certain hard mask film deposition processes, one-quarter of film thickness may be deposited at each of four stations in accordance with the disclosed embodiments. Of course, the full film deposition may occur entirely at a single station or any fraction of the total film thickness may be deposited at any number of stations.

[0290] While in process, each wafer is held in place by a pedestal, wafer chuck and/or other wafer holding apparatus. For certain operations in which the wafer is to be heated, the apparatus may include a heater such as a heating plate. In certain embodiments, a Vector® reactor, manufactured by Lam Research, Inc. of Fremont, CA, may be used to implement the disclosed embodiments.

[0291] Fig. 6 provides a block diagram depicting various reactor components, which may be put into play to deposit a carbon-containing film from acetylene and in which the components can be controlled by way of a system controller 628. As shown, a reactor 600 includes a process chamber 624, which encloses other components of the reactor and serves to contain the plasma generated by a capacitor type system including a showerhead 614 working in conjunction with a grounded heater block 620. A high-frequency RF generator 604, connected to a matching network 606, and a low-frequency RF generator 602 are connected to showerhead 614. Alternatively, a low-frequency RF generator 602 may connected to the substrate 616. The power and frequency supplied by the matching network 606 is sufficient to generate a plasma from the process gas, for example 400-700W total energy. In a typical process, the high frequency RF component is generally between 2-60MHz; in certain embodiments, the HF component is about 13.56 MHz. The LF component can be from about 100 kHz – 2 MHz; in certain embodiments, the LF component is 400 kHz.

CLAIMS

~~*What is claimed is:*~~

1. A composition comprising a mixture or solution of:

acetylene; and

a stabilizer comprising an amide having a vapor pressure of about 3 Torr or lower at 25° C, an amine, an imine, a nitrile having a vapor pressure of about 80 Torr or lower at 25° C, a nitrogen-containing saturated heterocyclic ring compound, a nitrogen-containing unsaturated heterocyclic ring compound, an unsaturated linear or branched hydrocarbon, an unsaturated ring hydrocarbon having a vapor pressure of about 5 Torr or lower at 25° C, a non-aromatic unsaturated ring hydrocarbon, an ether, a ketone, an aldehyde, an ester having a vapor pressure of about 90 Torr or lower at 25° C, an ionic liquid, a carbene, a silylene, a mixed electron donor compound comprising a pi bond and an atom having a lone electron pair, a phosphorus-containing compound in which the phosphorus atom has a lone electron pair, or a sulfur-containing compound in which the sulfur atom has a lone electron pair,

wherein the ketone has a vapor pressure of about 30 Torr or lower at 25° C; or wherein the ketone is selected from the group consisting of acetylacetone (acac), 2-butanone, 2-pentanone, 2-hexanone, 2-heptanone, 2-octanone, 2-nonanone, 2-decanone, 3-pentanone, 3-heptanone, 3-octanone, 3-nonanone, 3-decanone, cyclohexanone, and aromatic ~~aldehydes such as~~ketones comprising acetophenone, 3-hydroxyacetophenone, ~~cyclohexanone,~~ benzophenone, butyrophenone, acetylpyrazine, 2-acetyl pyridine, acrylophenone, capillin, dibenzoylmethane, indenone, 1-indanone, paroxypropione, phenylglyoxal, piceol, propriophenone, pyridoxal, 2,4,6-trihydroxyacetophenone, 2,4,5-trihydroxyacetophenone, ~~and~~or valerophenone.

2. The composition of claim 1, wherein the stabilizer is the ionic liquid comprising a cation selected from the group consisting of imidazolium, pyridinium, ammonium, phosphonium, thiazolium, and triazolium.

3. The composition of claim 1, wherein the stabilizer is the carbene selected from the group consisting of transition metal carbene complexes, *N*-heterocyclic carbenes, and methylenes.

4. The composition of claim 1, wherein the stabilizer is the silylene or an *N*-heterocyclic silylene.

5. The composition of claim 1, wherein the stabilizer comprises the ketone having a vapor pressure of about 30 Torr or lower at 25° C.

6. The composition of claim 1, wherein the stabilizer comprises the ketone selected from the group consisting of acetylacetone (acac), 2-butanone, 2-pentanone, 2-hexanone, 2-heptanone, 2-octanone, 2-nonanone, 2-decanone, 3-pentanone, 3-heptanone, 3-octanone, 3-nonanone, 3-decanone, cyclohexanone, and aromatic ~~aldehydes such as~~ketones comprising acetophenone, 3-hydroxyacetophenone, ~~cyclohexanone,~~ benzophenone, butyrophenone, acetylpyrazine, 2-acetyl pyridine, acrylophenone, capillin, dibenzoylmethane, indenone, 1-indanone, paroxypropione, phenylglyoxal, piceol, propriophenone, pyridoxal, 2,4,6-trihydroxyacetophenone, 2,4,5-trihydroxyacetophenone, ~~and~~or valerophenone.

7. The composition of claim 1, wherein the stabilizer comprises the aldehyde.

~~8. The composition of claim 7, wherein the stabilizer is benzaldehyde.~~

~~9.~~8. The composition of claim 1, wherein the stabilizer comprises the ester having a vapor pressure of about 90 Torr or lower at 25° C.

~~10.~~9. The composition of claim 1, wherein the stabilizer comprises the amide having a vapor pressure of about 3 Torr or lower at 25° C.

~~11.~~10. The composition of claim 1, wherein the stabilizer comprises the ether.

~~12. The composition of claim 11, wherein the stabilizer is selected from the group consisting of furan, tetrahydrofuran, and pyran.~~

~~13.~~11. The composition of claim 1, wherein the stabilizer comprises the amine, and wherein the amine is selected from the group consisting of *N*-ethyldiisopropylamine, trimethylamine, dimethylamine, methylamine, triethylamine, and tert-butylamine.

~~14. The composition of claim 13, wherein the amine is selected from the group consisting of *N*-ethyldiisopropylamine, trimethylamine, dimethylamine, methylamine, triethylamine, and tert-butylamine.~~

~~15. The composition of claim 13, wherein the amine is an aromatic amine.~~

~~16. The composition of claim 15, wherein the aromatic amine is selected from the group consisting of aniline, *N,N*-dimethylaniline, piperidine, pyrrole, pyrrolidine, pyridine, piperidine, imidazole, and pyrimidine.~~

~~17.~~12. The composition of claim 1, wherein the stabilizer comprises the imine.

~~18. The composition of claim 17, wherein the imine is selected from the group consisting of Schiff bases and 2,5-cyclohexadiene-1,4-diimine.~~

~~19.~~13. The composition of claim 1, wherein the stabilizer comprises the nitrile having a vapor pressure of about 80 Torr or lower at 25° C.

~~20.~~14. The composition of claim 1, wherein the stabilizer comprises the nitrogen-containing saturated heterocyclic ring compound.

~~21. The composition of claim 20, wherein the nitrogen-containing saturated heterocyclic ring compound is selected from the group consisting of pyrrolidine and morpholine.~~

~~22.~~15. The composition of claim 1, wherein the stabilizer comprises the nitrogen-containing unsaturated heterocyclic ring compound, wherein the nitrogen-containing unsaturated heterocyclic ring compound is selected from the group consisting of pyridine, pyrazine, imidazole, pyrrole, *N*-iminopyridinium ylide, triazole, thiazole, and substituted derivatives thereof.

~~23. The composition of claim 22, wherein the nitrogen-containing unsaturated heterocyclic ring compound is selected from the group consisting of pyridine, pyrazine,~~

~~imidazole, pyrrole, *N*-iminopyridinium ylide, triazole, thiazole, and substituted derivatives of any of these such as *N*-methylimidizole, 2,6-lutidine, and 4-*N,N*-dimethylaminopyridine.~~

~~24.~~16. The composition of claim 1, wherein the stabilizer comprises the mixed electron donor compound comprising a pi bond and an atom having a lone electron pair, and wherein the mixed electron donor compound is selected from the group consisting of acetone, imine, 2-methyl-2-butenone, triazole, and thiazole.

~~25. The composition of claim 24, wherein the mixed electron donor compound is selected from the group consisting of acetone, imine, 2-methyl-2-butenone, triazole, and thiazole.~~

~~26.~~17. The composition of claim 1, wherein the stabilizer comprises the phosphorus-containing compound in which the phosphorus atom has a lone electron pair.

~~27. The composition of claim 26, wherein the phosphorus-containing compound is selected from the group consisting of triphenylphosphine and triphenylphosphine oxide.~~

~~28.~~18. The composition of claim 1, wherein the stabilizer comprises the sulfur-containing compound in which the sulfur atom has a lone electron pair.

~~29. The composition of claim 28, wherein the sulfur-containing compound is selected from the group consisting of thiophene, thiazolium, thiazole, 2-methylthiophene, 3-methylthiophene, 2,4-dimethylthiophene, benzothiophene, and 2-methylbenzothiophene.~~

~~30.~~19. The composition of claim 1, wherein the stabilizer comprises the unsaturated linear or branched hydrocarbon.

~~31. The composition of claim 30, wherein the unsaturated linear or branched hydrocarbon is selected from the group consisting of butene, butadiene, 1-butyne, propyne, pentene, octene, heptene, hexyne, 1-heptyne, 1-octyne, 1-nonyne, and 1-decyne.~~

~~32.~~20. The composition of claim 1, wherein the stabilizer comprises the unsaturated ring hydrocarbon having a vapor pressure of about 5 Torr or lower at 25° C.

~~33.~~21. The composition of claim 1, wherein the stabilizer comprises the non-aromatic unsaturated ring hydrocarbon.

~~34. The composition of claim 33, wherein the stabilizer is cyclopentene or cyclohexene.~~

~~35. The composition of any one of claims 1-34, wherein the acetylene and the stabilizer are stored in a containment vessel.~~

~~36.~~22. The composition of ~~any one of~~ claim~~s~~ 1~~-35~~, wherein the acetylene and stabilizer are stored under a pressure of at least about 200 psi.

~~37.~~23. A stabilized composition comprising:

a pressurized acetylene; and

a stabilizer is a stabilizer comprising a nitrogen atom, wherein the stabilizer is not dimethylformamide, not dimethylacetamide, not *N*-methyl-2-pyrrolidone, and not acetonitrile; a heterocycle, wherein the stabilizer is not 1,3-dioxolane, not 1,4-dioxane, and not *N*-methyl-2-pyrrolidone; a substituted aromatic hydrocarbon having one or more substitutions, wherein the one or more substitutions are selected from the group consisting of halo, amine, and optionally substituted $C_{2\text{-}8}$ alkyl; an optionally substituted alkene or an optionally substituted alkyne; an aldehyde or an ether, wherein the stabilizer is not 1,3-dioxolane and not 1,4-dioxane; an ester selected from the group consisting of a cyclic ester, a glycol based ester, a lactate, a carbonate ester, an amino ester, and a diester; a cyclic ketone, an aryl ketone, a dione, or a trione; a carbene or a carbene derivative; a metal compound, an onium compound, an organosulfur compound, or an organophosphorus compound, wherein the stabilizer is not dimethylsulfoxide; or an ionic liquid.

~~38.~~24. The stabilized composition of claim ~~37~~ 23, wherein the stabilizer is the stabilizer comprising the nitrogen atom and further comprises optionally substituted heterocyclyl.

~~39.~~25. The stabilized composition of claim ~~37~~ 23, wherein the stabilizer is the stabilizer comprising the nitrogen atom and is an amide, an amine, a guanidine, an imine, or an N-heterocyclic carbene.

~~40.~~26. The stabilized composition of claim ~~37~~ 23, wherein the stabilizer is the stabilizer comprising the nitrogen atom and is an amide selected from the group consisting of a dialkyl amide, a pyrrolidone, an acetamide, a morpholide, an ester amide, and a cyclic amide.

~~41.~~27. The stabilized composition of claim ~~37~~ 23, wherein the stabilizer is the stabilizer comprising the nitrogen atom and is an amine comprising optionally substituted aliphatic, optionally substituted alkyl, optionally substituted aryl, optionally substituted aliphatic-aryl, optionally substituted alkyl-aryl, optionally substituted alkenyl-aryl, optionally substituted alkynyl-aryl, optionally substituted heteroaliphatic, optionally substituted heteroalkyl, optionally substituted heterocyclyl, or optionally substituted alkyl-heterocyclyl.

~~42.~~28. The stabilized composition of claim ~~37~~ 23, wherein the stabilizer is the stabilizer comprising the nitrogen atom and is a Schiff base.

~~43.~~29. The stabilized composition of claim ~~37~~ 23, wherein the stabilizer is the heterocycle, and wherein the stabilizer is not 1,3-dioxolane, not 1,4-dioxane, and not *N*-methyl-2-pyrrolidone.

~~44. The stabilized composition of claim 43, wherein the heterocycle is an aromatic heterocycle, a bicyclic heterocycle, a cyclic ether, a cyclic ester, a cyclic carbonate ester, a cyclic amine, a cyclic amide, or an N-heterocyclic carbene.~~

~~45. The stabilized composition of claim 43, wherein the heterocycle comprises one or more heteroatoms selected from the group consisting of N, O, or S.~~

~~46.~~30. The stabilized composition of claim ~~37~~23, wherein the stabilizer is the substituted aromatic hydrocarbon having one or more substitutions, and wherein the one or more substitutions are selected from the group consisting of halo, amine, and optionally substituted $C_{2\text{-}8}$ alkyl.

~~47. The stabilized composition of claim 46, wherein the aromatic hydrocarbon comprises a first substitution selected from the group consisting of halo, amine, and optionally~~

~~substituted C_{2-8} alkyl and a second substitution selected from the group consisting of halo, amine, and optionally substituted alkyl.~~

~~48.~~31. The stabilized composition of claim ~~37~~23, wherein the stabilizer is the optionally substituted alkene or the optionally substituted alkyne.

~~49. The stabilized composition of claim 48, wherein the optionally substituted alkene is a diene.~~

~~50.~~32. The stabilized composition of claim ~~37~~23, wherein stabilizer is the aldehyde or the ether, and wherein the stabilizer is not 1,3-dioxolane and not 1,4-dioxane.

~~51. The stabilized composition of claim 50, wherein the aldehyde comprises an optionally substituted aliphatic, optionally substituted alkyl, optionally substituted aryl, optionally substituted aliphatic-aryl, optionally substituted alkyl-aryl, optionally substituted alkenyl-aryl, optionally substituted alkynyl-aryl, optionally substituted heteroaliphatic, optionally substituted heteroalkyl, optionally substituted heterocyclyl, or optionally substituted alkyl-heterocyclyl having one or more aldehyde moieties.~~

~~52. The stabilized composition of claim 50, wherein the ether comprises optionally substituted aliphatic, optionally substituted alkyl, optionally substituted aryl, optionally substituted aliphatic-aryl, optionally substituted alkyl-aryl, optionally substituted alkenyl-aryl, optionally substituted alkynyl-aryl, optionally substituted heteroaliphatic, optionally substituted heteroalkyl, optionally substituted heterocyclyl, or optionally substituted alkyl-heterocyclyl.~~

~~53.~~33. The stabilized composition of claim ~~37~~23, wherein the stabilizer is the ester selected from the group consisting of a cyclic ester, a glycol based ester, a lactate, a carbonate ester, an amino ester, and a diester.

~~54. The stabilized composition of claim 53, wherein the ester comprises one or more amino.~~

~~55.~~34. The stabilized composition of claim ~~37~~23, wherein the stabilizer is the cyclic ketone, the aryl ketone, the dione, or the trione.

~~56. The stabilized composition of claim 55, wherein the stabilizer comprises optionally substituted cycloalkyl or optionally substituted aryl.~~

~~57.~~35. The stabilized composition of claim ~~37~~23, wherein the stabilizer is the carbene or the carbene derivative.

~~58. The stabilized composition of claim 57, wherein the carbene comprises optionally substituted aliphatic, optionally substituted alkyl, optionally substituted aryl, optionally substituted aliphatic-aryl, optionally substituted alkyl-aryl, optionally substituted alkenyl-aryl, optionally substituted alkynyl-aryl, or optionally substituted heterocyclyl; or .~~

~~59. The stabilized composition of claim 57, wherein the carbene or the carbene derivative comprises a thiazol-2-ylidene moiety, a dihydroimidazol-2-ylidene moiety, an imidazol-2-ylidene moiety, a phosphinocarbene moiety, a triazol-5-ylidene moiety, or a cyclopropenylidene moiety.~~

~~60. The stabilized composition of claim 57, wherein the carbene or the carbene derivative is selected from the group consisting of an aminothiocarbene compound, an aminooxycarbene compound, a diaminocarbene compound, a heteroamino carbene compound, a 1,3-dithiolium carbene compound, a mesoionic carbene compound, a cyclic alkyl amino carbene compound, a boranylidene compound, a silylene compound, a stannylene compound, a nitrene compound, a phosphinidene compound, and a foiled carbene compound.~~

~~61.~~36. The stabilized composition of claim ~~37~~23, wherein the stabilizer is the metal compound, the onium compound, the organosulfur compound, or the organophosphorus compound, wherein the stabilizer is not dimethylsulfoxide.

~~62. The stabilized composition of claim 61, wherein the onium compound is selected from the group consisting of a nitronium ion, a nitrosonium ion, a bis(triphenylphosphine) iminium ion, an iminium ion, a diazenium ion, a guanidinium ion, a nitrilium ion, a diazonium ion, a pyridinium ion, a pyrylium ion, and a thionitrosyl ion.~~

~~63. The stabilized composition of claim 61, wherein the organosulfur compound is selected from the group consisting of a thioester, a sulfoxide, a sulfone, a thiosulfinate, a sulfimide, a sulfoximide, a sulfonediimine, an S-nitrosothiol, a thioketone, a thioaldehyde, a thioamide, a sulfonium, an oxosulfonium, and a thiocarbonyl ylide.~~

~~64. The stabilized composition of claim 61, wherein the organophosphorus compound is selected from the group consisting of a phosphate ester, a phosphate amide, a phosphonate, a phosphinate, a phosphine oxide, a phosphine imide, and a phosphonium salt.~~

~~65.~~37. The stabilized composition of claim ~~37~~23, wherein the stabilizer is the ionic liquid.

~~66. The stabilized composition of claim 65, wherein the ionic liquid comprises a cationic moiety comprising imidazolium, pyridinium, pyrrolidinium, ammonium, phosphonium, thiazolium, or triazolium; and further comprises an anionic moiety comprising tetrafluoroborate, hexafluorophosphate, bistriflimide, triflate, acetate, trifluoroacetate, triflimide, halide, bis(trifluoromethylsulfonyl)imide, methylsulfate, ethyl sulfate, docusate, or dicyanamide.~~