SUMMARY

[0005] Applicant determined that decreasing the bond energy of the Sn-C bond could improve performance of the Sn photosensitive materials in certain uses (photolytic cleavage of Sn-C bonds during exposure to EUV would promote cross-linking hence making these materials superior negative photoresist). Ligands containing unsaturated hydrocarbons, such as allyl, may provide decreased bond energy of the Sn-C bond.

[0006] Despite the foregoing advantages of decreasing the bond energy of the Sn-C bond in photosensitive materials, it is also contemplated that strengthening the Sn-C bond in photosensitive materials may also be advantageous in photosensitive materials in other uses. Ligands containing unsaturated hydrocarbons, such as vinyl, may provide increased bond energy of the Sn-C bond. By strengthening the Sn-C bond, some ligands bonded to Sn may be retained in the deposited film for further EUV treatment, which may be advantageous in particular uses.

[0007] In addition, amino, alkoxy, or halide ligands enable reactivity with OH groups of wafers/substrate layers for effective ALD deposition. Thus, Applicant discovered that organometallics of tin having a combination of ligands containing unsaturated hydrocarbons and ligands containing amino, alkoxy, or halide ligands have improved properties for deposition, especially atomic layer deposition, and for use as a photosensitive material in patterning applications.

[0008] In one example, disclosed are organometallic compounds of Formula I, below:

$(R)_xSn(A)_{4-x}$ Formula I

wherein:

R is substituted Cp, unsubstituted Cp, or a non-cyclic unsaturated hydrocarbon having 2 to 10 carbon atoms, or 2 to 8 carbon atoms, or 2 to 4 carbon atoms;

A is NR^1R^2, OR^3, pyrrolidinyl, pyrrolyl, or halide;

R^1 and R^2 are each an alkyl group having from 1 to 10 carbon atoms;

R^1 and R^2 can be the same or different;

R^3 is an alkyl group having 2 to 8 carbon atoms;

x is an integer from 1 to 3; and

when A is NR^1R^2, pyrrolidinyl, pyrrolyl, or halide, R is substituted Cp or a non-cyclic unsaturated hydrocarbon having 2 to 10 carbon atoms, or 2 to 8 carbon atoms, or 2 to 4 carbon atoms.

[0008a] In an aspect, there is provided an organometallic compound of Formula I:

$(R)_xSn(A)_{4-x}$ Formula I

wherein:

R is substituted Cp, or a non-cyclic unsaturated hydrocarbon having 2 to 10 carbon atoms, or 2 to 8 carbon atoms, or 2 to 4 carbon atoms;

A is NR^1R^2, OR^3, pyrrolidinyl, or pyrrolyl;

R^1 and R^2 are each independently selected from the group consisting of an alkyl group having from 1 to 10 carbon atoms, an aryl group, and an acyl group;

R^3 is selected from the group consisting of an alkyl group having 1 to 10 carbon atoms, an aryl group, or an acyl group;

x is an integer from 1 to 3;

when A is OR^3, then R is a vinyl group;

when R is a vinyl group, x is 3, and A is NR^1R^2, then at least one of R^1 and R^2 is not Et; and

substituted Cp has the formula $C_5R^{12}R^{13}R^{14}R^{15}R^{16}$, wherein at least one of R^{12}, R^{13}, R^{14}, R^{15}, R^{16} is H and at least one other of R^{12}, R^{13}, R^{14}, R^{15}, R^{16} is an alkyl group having from 1 to 10 carbon.

[0009] In embodiments, R is an allyl or vinyl group. In some embodiments, the allyl or vinyl group can be straight chain. Alternatively, the allyl group can be a substituted allyl group having the general formula: $CR^4R^5CR^6=CR^7R^8$, wherein R^4, R^5, R^6, R^7, and R^8 are each independently selected from the group consisting of H and alkyl groups having from 1 to 4 carbon atoms. Similarly, the vinyl group can be a substituted vinyl group having the general formula: $CR^9=CR^{10}R^{11}$, wherein R^9, R^{10}, and R^{11} are each independently selected from the group consisting of H and alkyl groups having from 1 to 4 carbon atoms.

[0010] In other embodiments, R is Cp, which is a cyclopentadienyl group having R^{12}, R^{13}, R^{14}, R^{15}, and R^{16} constituents. Depending on A, Cp can be substituted or unsubstituted. R^{12}, R^{13}, R^{14}, R^{15}, and R^{16} each independently selected from H and an alkyl group having from 1 to 10 carbon atoms, such as methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, or decyl. R^{12}, R^{13}, R^{14}, R^{15}, and R^{16} can be the same or different. However, when A is NR^1R^2, pyrrolidinyl,