CLAIMS

1. A disubstituted alkyne dicobalt hexacarbonyl compound having the formula: $Co_2(CO)_6(R_1C\Xi CR_2)$;

   wherein

   $R_1$ is tert-amyl and $R_2$ is selected from the group consisting of a linear alkyl group having at least two carbon atoms, isopropyl and isobutyl.

2. The disubstituted alkyne dicobalt hexacarbonyl compound of Claim 1, wherein the linear alkyl group is selected from the group consisting of n-ethyl, n-propyl, n-butyl, n-pentyl, and n-hexyl.

3. The disubstituted alkyne dicobalt hexacarbonyl compound of Claim 1 is a liquid compound at a temperature equal and less than 30 $^0$C.

4. A method of synthesizing a disubstituted alkyne dicobalt hexacarbonyl compound, comprising steps of:
   adding disubstituted alkyne complex into dicobalt octacarbonyl in a solvent; wherein

   the disubstituted alkyne complex has a structure of $R_1C\Xi CR_2$; wherein $R_1$ is tert-amyl and $R_2$ is selected from the group consisting of a linear alkyl group having at least two carbon atoms, isopropyl and isobutyl; and

   the disubstituted alkyne complex reacts with the dicobalt octacarbonyl in the solvent to form the disubstituted alkyne dicobalt hexacarbonyl compound.

5. The method of Claim 4, wherein the linear alkyl group is selected from the group consisting of n-ethyl, n-propyl, n-butyl, n-pentyl, and n-hexyl.

6. The method of Claim 4, wherein
   the solvent is selected from the group consisting of hexanes, tetrahydrofuran, diethyl ether, toluene, and combinations thereof.

7. The method of Claim 4, wherein
the solvent is hexanes.

8. The method of Claim 4, wherein the disubstituted alkyne dicobalt hexacarbonyl compound is a liquid compound at a temperature equal and less than 30 $^{0}$C.

9. A method of depositing a Co film containing less than 0.5 at. % of carbon on a substrate in a reactor, comprising:
providing the substrate to the reactor;
providing a Co precursor to the reactor;
contacting the substrate with the Co precursor; and
forming the Co film on the substrate;
wherein the Co precursor is a disubstituted alkyne dicobalt hexacarbonyl compound having the formula $Co_2(CO)_6$ ($R_1C\Xi CR_2$); wherein $R_1$ is a tertiary alkyl group and $R_2$ is a linear alkyl group, isopropyl and isobutyl; and
the substrate is selected from the group consisting of metal, metal oxide, metal nitride, silicon, silicon oxide, silicon nitride, TaN, and combinations thereof.

10. The method of Claim 9, wherein the tertiary alkyl group is selected from the group consisting of tert-butyl and tert-amyl; and the linear alkyl group is selected from the group consisting of n-ethyl, n-propyl, and n-butyl, n-pentyl, and n-hexyl.

11. The method of Claim 9, wherein
the disubstituted alkyne dicobalt hexacarbonyl compound is selected from the group consisting of (2,2,6-Trimethyl-3-heptyne) dicobalt hexacarbonyl (CCTIBA); (2,2-Dimethyl-3-octyne) dicobalt hexacarbonyl (CCTNBA); (2,2-Dimethyl-3-decyne) dicobalt hexacarbonyl (CCTHA); (2,2-Dimethyl-3-heptyne) dicobalt hexacarbonyl (CCTPA); and (tert-butylmethylacetylene)dicobalt hexacarbonyl (CCTMA).

12. The method of Claim 9, wherein the disubstituted alkyne dicobalt hexacarbonyl compound is a liquid compound at a temperature equal and less than 30 $^{0}$C.

13. The method of Claim 12, wherein the disubstituted alkyne dicobalt hexacarbonyl compound is (2,2-Dimethyl-3-octyne) dicobalt hexacarbonyl (CCTNBA).

14. The method of Claim 9, wherein the Co film is selected from a group consisting of cobalt film, cobalt oxide film, cobalt silicide film, cobalt nitride film, and combinations thereof.

15. The method of Claim 9, wherein the Co film is deposited by a method selected from a group consisting of thermal CVD, thermal ALD, plasma-enhanced ALD (PEALD), plasma enhanced chemical vapor deposition (PECVD), and plasma enhanced cyclic chemical vapor deposition (PECCVD).

16. A cobalt containing film deposited by using a disubstituted alkyne dicobalt hexacarbonyl compound having the formula $Co_2(CO)_6$ ($R_1C\Xi CR_2$); wherein $R_1$ is a tertiary alkyl group and $R_2$ is a linear alkyl group, isopropyl and isobutyl, and wherein the cobalt containing film contains less than 0.5 at. % of carbon.

17. The cobalt containing film of Claim 16, wherein the tertiary alkyl group is selected from the group consisting of tert-butyl and tert-amyl; and the linear alkyl group is selected from the group consisting of n-ethyl, n-propyl, and n-butyl, n-pentyl, and n-hexyl.

18. The cobalt containing film of Claim 16, wherein
the disubstituted alkyne dicobalt hexacarbonyl compound is selected from the group consisting of (2,2,6-Trimethyl-3-heptyne) dicobalt hexacarbonyl (CCTIBA); (2,2-Dimethyl-3-octyne) dicobalt hexacarbonyl (CCTNBA); (2,2-Dimethyl-3-decyne) dicobalt hexacarbonyl (CCTHA); (2,2-Dimethyl-3-

heptyne) dicobalt hexacarbonyl (CCTPA); and (tert-butylmethylacetylene)dicobalt hexacarbonyl (CCTMA).

19. The cobalt containing film of Claim 16, wherein the disubstituted alkyne dicobalt hexacarbonyl compound is a liquid compound at a temperature equal and less than 30 $^{0}$C.

20. The cobalt containing film of Claim 19, wherein the disubstituted alkyne dicobalt hexacarbonyl compound is (2,2-Dimethyl-3-octyne) dicobalt hexacarbonyl (CCTNBA).

21. The cobalt containing film of Claim 16, wherein the cobalt containing film is selected from a group consisting of cobalt film, cobalt oxide film, cobalt silicide film, and cobalt nitride film.

22. The cobalt containing film of Claim 16, wherein the cobalt containing film is deposited by using a method selected from a group consisting of thermal CVD, thermal ALD, plasma-enhanced ALD (PEALD), plasma enhanced chemical vapor deposition (PECVD), and plasma enhanced cyclic chemical vapor deposition (PECCVD).