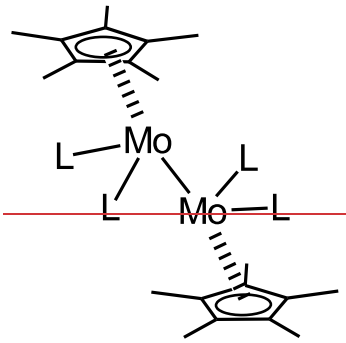
~~**What is claimed is:**~~

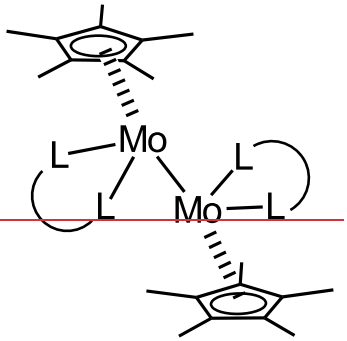
CLAIMS

~~1.~~ A metal coordination complex ~~comprising a dinuclear molybdenum and a sterically or electronically adapted phosphine ligand or derivative thereof, the metal coordination complex substantially free of oxygen, halogen, and carbonyl.~~

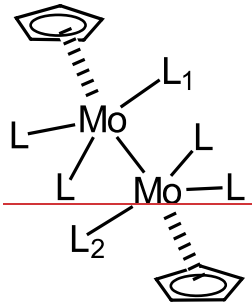
1. ~~The metal coordination complex of claim 1~~ having a structure of Formula (I), Formula (II), Formula (III), or Formula (IV):



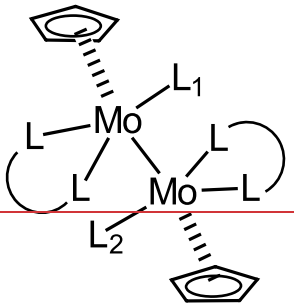
(I)



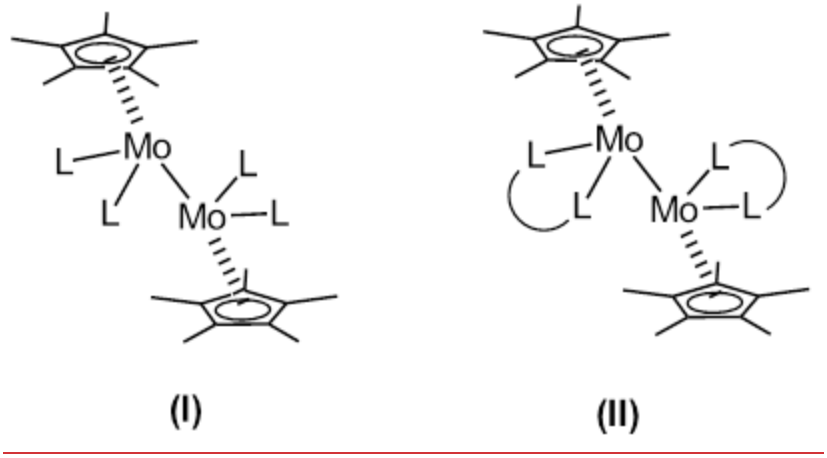
(II)



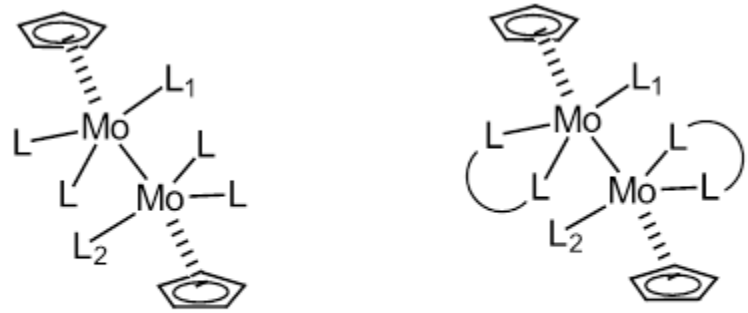
(III)



(IV)

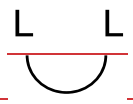


(I) (II)



(III) (IV)

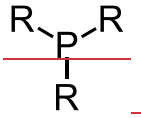
wherein Mo-Mo is dinuclear molybdenum,



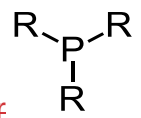
~~L and are independently the sterically or electronically adapted phosphine ligand or derivative thereof, and~~

~~one or more of L_1 and L_2 are independently the sterically or electronically adapted phosphine ligand or derivative thereof, or a carbonyl ligand or derivative thereof.~~

~~The metal coordination complex of claim 2, wherein~~ L is independently



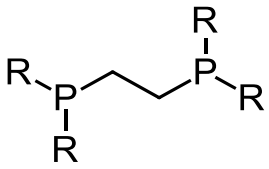
~~or~~



~~,~~

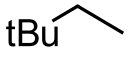


is independently



, ~~and~~or R is independently a substituted or unsubstituted C_1-C_{10} alkyl group~~.~~, and

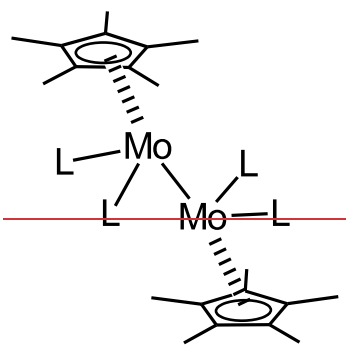
one or more of L_1 and L_2 are independently a sterically or electronically adapted phosphine ligand or a carbonyl ligand.

2. The metal coordination complex of claim ~~3~~1, wherein R is independently selected from Me-, Et-, iPr-, tBu-, and 

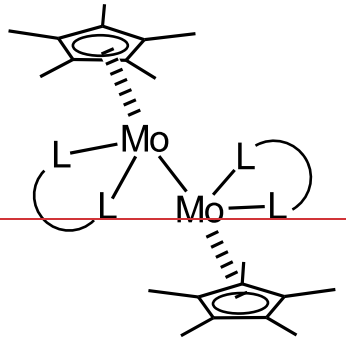
substituents.

3. A method of depositing a film, the method comprising:

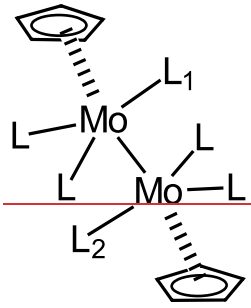
exposing a substrate to a dinuclear molybdenum coordination complex having a structure of Formula (I), Formula (II), Formula (III), or Formula (IV)



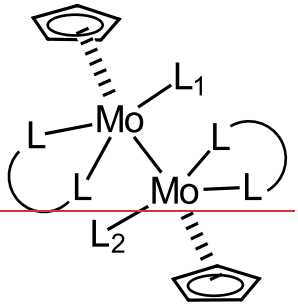
(I)



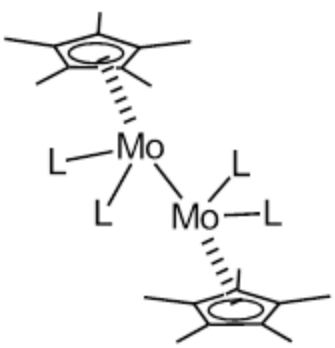
(II)



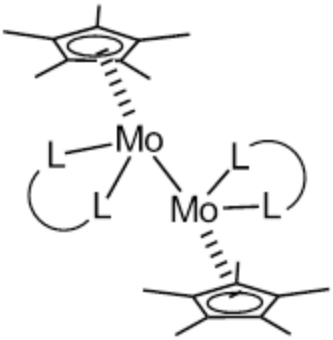
(III)



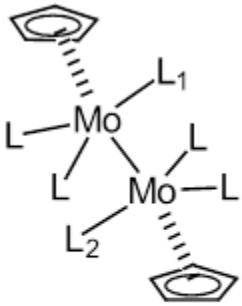
(IV)



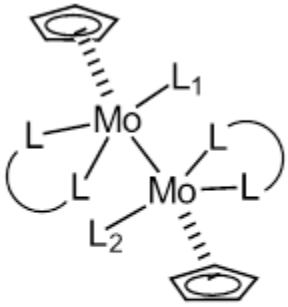
(I)



(II)

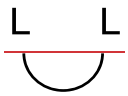


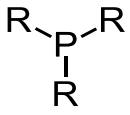
(III)



(IV)

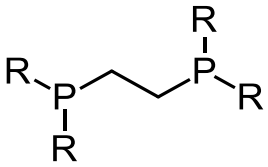
wherein Mo-Mo is dinuclear molybdenum,



~~L and~~ ~~are independently a sterically or electronically adapted phosphine ligand or derivative thereof, and~~ L is independently 

,[[and]]

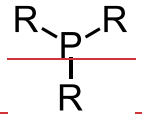
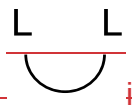
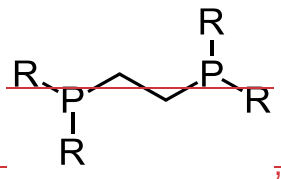


[[are]]is independently 

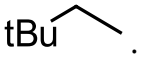
, or R is independently a substituted or unsubstituted C_1-C_{10} alkyl group, and

one or more of L_1 and L_2 are independently a sterically or electronically adapted phosphine ligand or ~~derivative thereof, or~~ a carbonyl ligand ~~or derivative thereof~~; and

exposing the substrate to a reactant to form a molybdenum-containing film on the substrate.

~~2. The method of claim 5, wherein L is independently~~  ~~and~~  ~~is independently~~  ~~, R is independently a substituted or unsubstituted C_1-C_{10} alkyl group.~~

~~The method of claim 6~~

4. The method of claim 3, wherein R is independently selected from Me-, Et-, iPr-, tBu-, and .

5. The method of claim ~~5~~3, wherein the method is one or more of chemical vapor deposition or atomic layer deposition.

6. The method of claim ~~5~~3, wherein the reactant is reacted with the film at a temperature in a range of from 100°C to <400°C.

7. The method of claim ~~5~~3, wherein the reactant comprises one or more of an oxidizing agent and a reducing agent.

8. The method of claim ~~5~~3, wherein the molybdenum-containing film comprises one or more of a molybdenum metal (elemental Mo) film, a molybdenum oxide film, a molybdenum carbide film, a molybdenum silicide film, and a molybdenum nitride film.

9. The method of claim ~~5~~3, wherein the substrate is exposed to the dinuclear molybdenum coordination complex and the reactant sequentially.

10. The method of claim ~~5~~3, wherein the substrate is exposed to the dinuclear molybdenum coordination complex and the reactant simultaneously.

11. The method of claim ~~5~~3, further comprising purging the substrate of the dinuclear molybdenum coordination complex prior to exposing the substrate to the reactant.

12. The method of claim ~~14~~11, wherein purging comprises one or more of applying a vacuum or flowing a purge gas over the substrate.

13. The method of claim ~~5~~3, further comprising repeating the method to provide a molybdenum-containing film having a thickness of about 0.3 to about 100 nm.

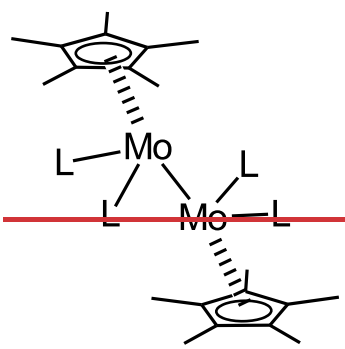
14. The method of claim ~~15~~12, wherein the purge gas comprises one or more of nitrogen (N_2), helium (He), and argon (Ar).

15. A method of depositing a film, the method comprising:

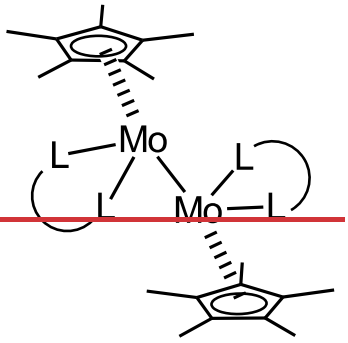
forming a molybdenum-containing film in a process cycle comprising sequential exposure of a substrate to a dinuclear molybdenum coordination complex precursor, purge gas, reactant, and purge gas~~.~~.

~~The method of claim 18,~~ wherein the dinuclear molybdenum coordination complex precursor has a structure of Formula (I), Formula (II), Formula (III), or Formula (IV):

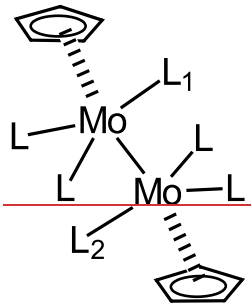
_____



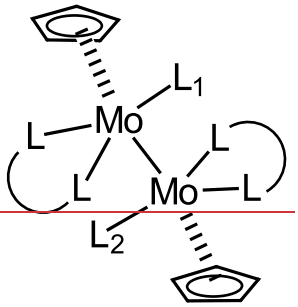
(I)



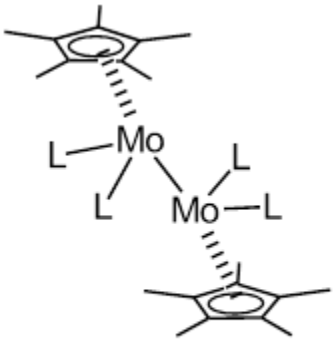
(II)



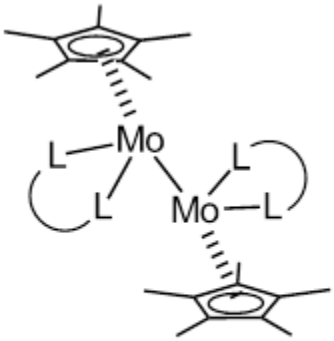
(III)



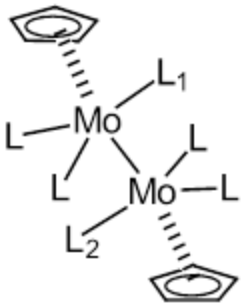
(IV)



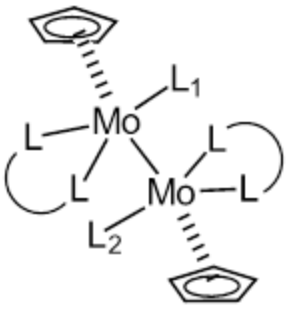
(I)



(II)

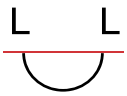


(III)



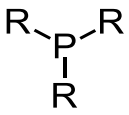
(IV)

wherein Mo-Mo is dinuclear molybdenum,

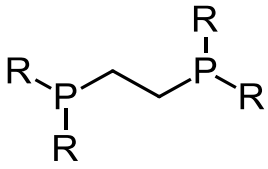


~~L and~~ ~~are independently a sterically or electronically adapted phosphine ligand or derivative thereof, and~~

~~one or more of L_1 and L_2 are independently the sterically or electronically adapted phosphine ligand or derivative thereof, or a carbonyl ligand or derivative thereof.~~

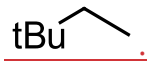
~~The method claim 19, wherein~~ L is independently 

, 

is independently 

, ~~and~~or R is independently a substituted or unsubstituted C_1-C_{10} alkyl group~~.~~, and

one or more of L_1 and L_2 are independently a sterically or electronically adapted phosphine ligand or a carbonyl ligand.

16. The method of claim 15, wherein R is independently selected from Me-, Et-, iPr-, tBu-, and 

.