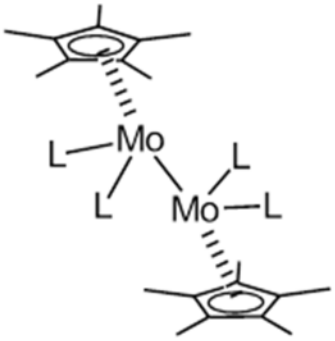
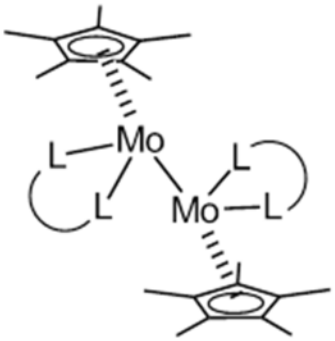
## CLAIMS

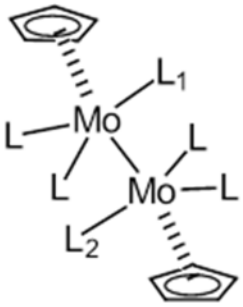
1. A metal coordination complex having a structure of Formula (I), Formula (II), Formula (III), or Formula (IV):



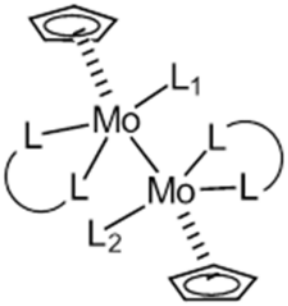

(I)




(II)

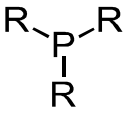



(III)

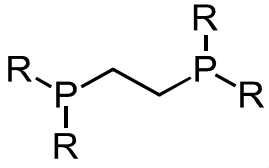



(IV)

wherein Mo-Mo is dinuclear molybdenum,

L is independently 

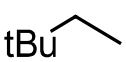
, 

is independently 

, or

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

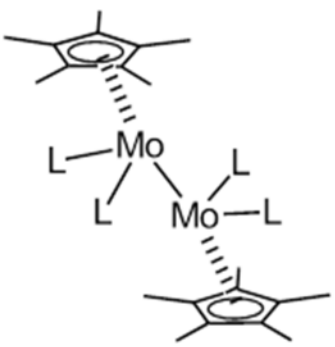
one or more of $L_1$ and $L_2$ are independently a sterically or electronically adapted phosphine ligand or a carbonyl ligand.

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

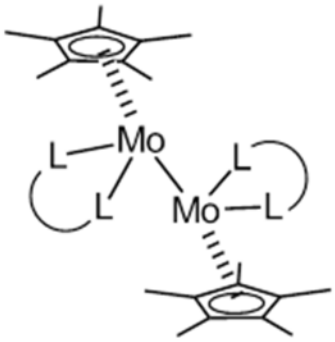
substituents.

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

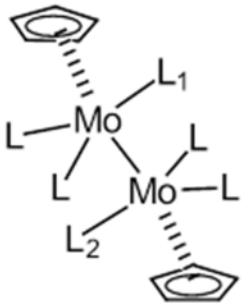
exposing a substrate to a dinuclear molybdenum coordination complex having a structure of Formula (I), Formula (II), Formula (III), or Formula (IV)



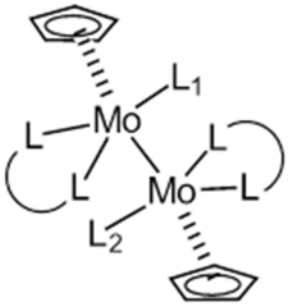

(I)




(II)

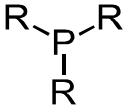


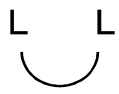

(III)

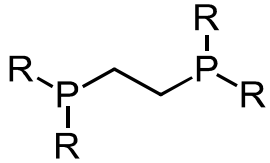



(IV)

wherein Mo-Mo is dinuclear molybdenum,

L is independently 

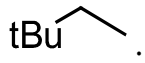
,[[and]] 

[[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 a carbonyl ligand; and

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

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

.

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

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

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

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

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

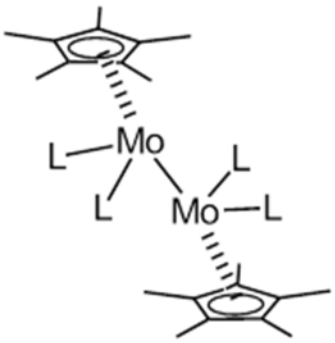
13. The method of claim 3, further comprising repeating the method to provide a molybdenum-containing film having a thickness of 0.3 to 100 nm.

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

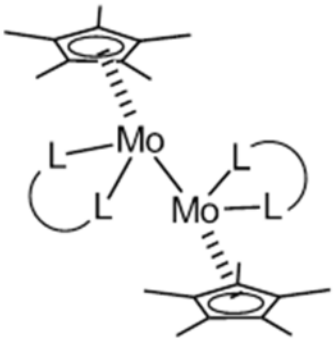
15. A method of depositing a film, the method comprising:

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,

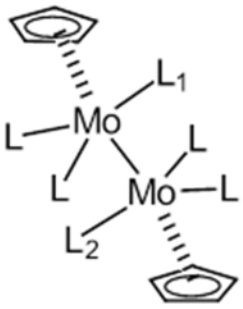
wherein the dinuclear molybdenum coordination complex precursor has a structure of Formula (I), Formula (II), Formula (III), or Formula (IV):



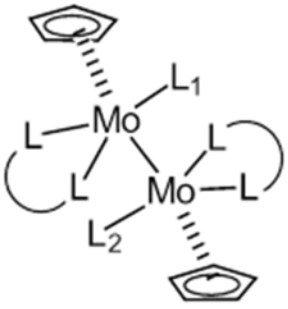

(I)




(II)

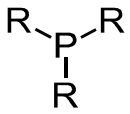
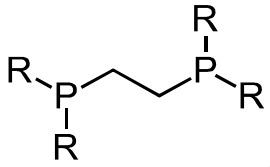



(III)



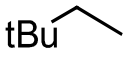

(IV)

wherein Mo-Mo is dinuclear molybdenum,

L is independently ,  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 a carbonyl ligand.

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