CLAIMS

1. A method of forming a transition metal dichalcogenide layer on a substrate, the method comprising:

providing a transition metal oxide, a chalcogen source, a non-gaseous chalcogen scavenger, and a substrate, wherein the substrate is disposed downstream of the transition metal oxide and the chalcogen source, and wherein the non-gaseous chalcogen scavenger is disposed in proximity to the transition metal oxide;

generating vapors of the transition metal oxide and vapors of the chalcogen source, wherein the non-gaseous chalcogen scavenger reacts preferentially with the vapors of the chalcogen source;

disposing the vapors generated from the transition metal oxide and the chalcogen source on the substrate; and

reacting the vapors of the transition metal oxide and the chalcogen source on the substrate to obtain the transition metal dichalcogenide layer on the substrate.

2. The method of claim 1, wherein providing the transition metal oxide, the chalcogen source, the non-gaseous chalcogen scavenger, and the substrate comprises disposing the non-gaseous chalcogen scavenger ~~upstream of~~between the substrate and the transition metal oxide~~ with respect to intended flow of vapors of the chalcogen source~~.

3. The method of claim 1 or 2, wherein generating vapors of the transition metal oxide and vapors of the chalcogen source comprises preventing vapors of the chalcogen source from reacting with the transition metal oxide.

4. The method of claim 3, wherein preventing vapors of the chalcogen source from reacting with the transition metal oxide comprises disposing a physical barrier between the transition metal oxide and the chalcogen source.

5. The method of any one of claims 1 to 4, wherein generating vapors of the transition metal oxide and vapors of the chalcogen source comprises heating the transition metal oxide and the chalcogen source to their respective temperature for vaporization.

6. The method of claim 5, wherein heating the transition metal oxide for vaporizing the transition metal oxide is carried out at a temperature in the range of ~~about~~ 650 °C to ~~about~~ 950 °C.

7. The method of claim 5 or 6, heating the transition metal oxide further comprises drying the transition metal oxide before vaporizing the transition metal oxide.

8. The method of claim 7, wherein drying the transition metal oxide is carried out at a temperature in the range of ~~about~~ 200 °C to ~~about~~ 300 °C.

9. The method of any one of claims 5 to 8, wherein heating the chalcogen source for vaporizing the chalcogen source is carried out at a temperature in the range of ~~about~~ 100 °C to ~~about~~ 300 °C.

10. The method of any one of claims 1 to 9, wherein disposing the vapors generated from the transition metal oxide and the chalcogen source on the substrate comprises directing a flow of inert gas at the vapors toward the substrate.

11. The method of any one of claims 1 to 10, wherein the transition metal oxide is selected from the group consisting of molybdenum oxide, tungsten oxide, chromium oxide, tin oxide, titanium dioxide, hafnium oxide, zirconium oxide, and a combination thereof.

12. The method of any one of claims 1 to 11, wherein the chalcogen source comprises sulfur, selenium, tellurium, or a combination thereof.

13. The method of any one of claims 1 to 12, wherein the non-gaseous chalcogen scavenger comprises or consists of nickel.

14. The method of any one of claims 1 to 13, wherein the substrate comprises sapphire, silicon, silicon dioxide, gallium nitride, aluminium nitride, a metal, a ceramic, or a combination thereof.

15. The method of any one of claims 1 to 14, wherein the transition metal dichalcogenide layer comprises molybdenum sulfide.

16. The method of any one of claims 1 to 15, wherein the method is carried out in an inert environment.

17. An arrangement for forming a transition metal dichalcogenide layer on a substrate, the arrangement comprising:

a transition metal oxide and a chalcogen source;

a substrate disposed downstream of the transition metal oxide and the chalcogen source; and

a non-gaseous chalcogen scavenger disposed in proximity to the transition metal oxide.

18. The arrangement of claim 17, wherein the arrangement further comprises an inert gas source adapted to provide an inert gas flow towards the substrate, wherein the chalcogen source is disposed in the path of the inert gas flow from the inert gas source towards the substrate.

19. The arrangement of claim 17 or 18, wherein the arrangement further comprises a respective heating element adapted to independently provide heat to the transition metal oxide and the chalcogen source for vaporizing the transition metal oxide and the chalcogen source.

20. The arrangement of any one of claims 17 to 19, wherein the arrangement further comprises a physical barrier disposed between the transition metal oxide and the chalcogen source.

21. The arrangement of claim 20, wherein the physical barrier is provided for by a chamber having an opening, wherein the transition metal oxide is disposed at a closed

end of the chamber and the non-gaseous chalcogen scavenger is disposed at the opening of the chamber.

22. The arrangement of claim 21, wherein the opening is positioned to face away from the chalcogen source.

23. The arrangement of claim 21 or 22, wherein the chalcogen source is disposed at a distance of ~~about~~ 100 mm to ~~about~~ 300 mm from the opening.

24. The arrangement of any one of claims 17 to 23, wherein the arrangement is disposed in an enclosure.

25. The arrangement of any one of claims 17 to 24, wherein the non-gaseous chalcogen scavenger is disposed at ~~about~~ 50 mm to ~~about~~ 150 mm from the chalcogen source.

26. The arrangement of any one of claims 17 to 25, wherein the substrate is disposed at ~~about~~ 5 mm to ~~about~~ 80 mm from the transition metal oxide.

27. The arrangement of any one of claims 17 to 26, wherein the transition metal oxide is selected from the group consisting of molybdenum oxide, tungsten oxide, chromium oxide, tin oxide, titanium dioxide, hafnium oxide, zirconium oxide, and a combination thereof.

28. The arrangement of any one of claims 17 to 27, wherein the chalcogen source comprises sulfur, selenium, tellurium, or a combination thereof.

29. The arrangement of any one of claims 17 to 28, wherein the non-gaseous chalcogen scavenger comprises or consists of nickel.

30. The arrangement of any one of claims 17 to 29, wherein the substrate comprises sapphire, silicon, silicon dioxide, gallium nitride, aluminium nitride, a metal, a ceramic, or a combination thereof.

31. The arrangement according to any one of claims 17 to 30, wherein the transition metal dichalcogenide layer comprises molybdenum sulfide.