Claims

1. A method, comprising:

performing an atomic layer deposition sequence comprising at least one deposition cycle, each cycle producing a monolayer of deposited material, the deposition cycle comprising introducing at least a first precursor species and a second precursor species to a substrate surface in a reaction chamber, wherein both of said first and second precursor species are present in gas phase in said reaction chamber simultaneously, and wherein the deposition cycle comprises an activation period and a regeneration period, and in the method:

during the activation period, the first precursor species adsorbed to the substrate surface in a preceding regeneration period is excited by photon energy, whereby the adsorbed first precursor species reacts on the surface with the second precursor species which is in gas phase; and

during a subsequent regeneration period, the first precursor species which is in gas phase reacts with the second precursor species adsorbed to the surface in the activation period.

2. The method of claim 1, wherein the second precursor species is used as carrier gas for the first precursor species.

3. The method of claim 1 or 2, wherein the excitation is implemented by photons emitted by a photon source which selected from a group comprising: an UV lamp, a LED lamp, a xenon lamp, an X-ray source, a laser source, and an infrared source.

4. The method of any preceding claim, wherein the substrate is selected from a group comprising: a wafer, metal foil, substrate web, paper, and nanocellulose.

5. The method of any preceding claim, wherein the first precursor species is excited by adjusting the wavelength of the photons.

6. The method of any preceding claim, wherein the method comprises switching off photon exposure by a shader or shader nozzle.

7. The method of any preceding claim, wherein the reaction chamber is surrounded by an outer chamber, the method comprising:

pressurizing an intermediate space between the outer chamber and the reaction chamber by conveying inactive gas to the intermediate space so that there is an overpressure in the intermediate space compared to the pressure in an interior of the reaction chamber.

8. The method of any preceding claim, wherein the flow of the first precursor species to the reaction chamber is off during the activation period and is on during the regeneration period, and the flow of the second precursor species to the reaction chamber is on during both the activation period and the regeneration period.

9. The method of any preceding claim, wherein the reactions are sequential self-saturating surface reactions.

10. The method of any preceding claim, wherein the first precursor is a metal precursor and the second precursor a non-metal precursor.

11. The method of any preceding claim, wherein the deposition cycles are performed without performing purge periods.

12. An apparatus, comprising:

a reaction chamber;

at least one in-feed line; and

a control system configured to control the apparatus to perform an atomic layer deposition sequence comprising at least one deposition cycle in the reaction chamber, each cycle producing a monolayer of deposited material, the deposition cycle comprising introducing at least a first precursor species

and a second precursor species via said at least one in-feed line to a substrate surface in the reaction chamber, wherein

the control system is further configured to control that precursor vapor of both of said first and second precursor species is present in gas phase in said reaction chamber simultaneously, and wherein the deposition cycle comprises an activation period and a regeneration period, and the apparatus comprises a photon source to excite, during the activation period by photon energy, the first precursor species adsorbed to the substrate surface in a preceding regeneration period whereby the adsorbed first precursor species reacts on the surface with the second precursor species which is in gas phase, the apparatus being further configured to cause:

during a subsequent regeneration period, the first precursor species which is in gas phase to react with the second precursor species adsorbed to the surface in the activation period.

13. The apparatus of claim 12, comprising a shader nozzle placed above the substrate in between the substrate and the photon source used both as a shader and as a precursor in-feed nozzle in the reaction chamber.

14. The apparatus of any preceding claim 12-13, wherein the reactions are sequential self-saturating surface reactions.

15. The apparatus of any preceding claim 12-14, wherein the first precursor is a metal precursor and the second precursor a non-metal precursor.

16. The apparatus of any preceding claim 12-15, wherein the control system is configured control that the deposition cycles are performed without performing purge periods.