

We claim:

1. A method comprising:
performing an inhibition treatment on the substrate in a chamber comprising
5 flowing co-flow pulses of a reactive inhibition gas from a first gas source and a metal
precursor gas from a second gas source to the chamber, wherein each co-flow pulse
comprises a pulse of the reactive inhibition gas and a pulse of the metal precursor gas,
wherein the pulse of the reactive inhibition gas and the pulse of the metal precursor gas,
as measured from when each gas is flowed from its it gas source, are offset and overlap
10 in time, and wherein the inhibition treatment inhibits metal nucleation.
2. The method of claim 1, wherein the pulse of the metal precursor gas and the
pulse of the reactive inhibition gas end or start at the same time.
- 15 3. The method of claim 1, wherein each pulse of the reactive inhibition gas is
separated from subsequent pulses of the reactive inhibition gas by a purge and each pulse
of the metal precursor gas is separated from subsequent pulses of the metal precursor gas
by a purge.
- 20 4. The method of any of the above claims wherein the metal is one of tungsten (W),
molybdenum (Mo), cobalt (Co), and ruthenium (Ru).
5. The method of claim 1, wherein the reactive inhibition gas is nitrogen-containing.
- 25 6. The method of claim 1, wherein the reactive inhibition gas is ammonia (NH₃) or
hydrazine (N₂H₄).
7. The method of claim 1, further comprising determining an offset from delay
parameters.
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8. The method of claim 8, wherein the offset is determined by optimizing within-
wafer uniformity.
9. The method of claim 1, further comprising, prior to the inhibition treatment,
35 depositing a first metal layer on the substrate.

10. The method of claim 9, further comprising, after the inhibition treatment, depositing a second metal layer on the substrate.
11. The method of claim 10, wherein deposition of the first metal layer is in a first station of a multi-station chamber, the inhibition treatment is in a second station of a multi-station chamber, and deposition of the second metal layer is in a third layer of a multi-station chamber.
12. The method of claim 1, wherein the reactive inhibition gas and the metal precursor gas mix only after exiting the showerhead.
13. An apparatus comprising:
- a chamber comprising one or more stations, each station comprising a pedestal and a showerhead disposed over the pedestal and configured to be fluidically connected to a first gas source and a second gas source; and
- a controller comprising instructions for:
- introducing multiple co-flow pulses of the first gas and the second gas into a station of the chamber, wherein each co-flow pulse comprises a pulse of the first gas and a pulse of the second gas, wherein the pulse of the first gas and the pulse of the second gas are offset and overlap in time, and wherein the each pulse of the first gas is separated from subsequent pulses of the first gas by a purge and each pulse of the second gas is separated from subsequent pulses of the second gas by a purge.
14. The apparatus of claim 13, wherein the controller further comprises instructions for determining an offset from one or more parameters.
15. The apparatus of claim 13, wherein the controller further comprises instructions for receiving the one or more parameters.
16. The apparatus of claim 15, wherein the one or more parameters comprise: the identity of a gas to be delayed, the length of offset, and the whether to shorten a pulse or purge.

17. The apparatus of any of claims 13–16, wherein the controller further comprises instructions for modifying a pulse sequence of the first gas or the second gas in accordance with the determined offset.

5 18. A method comprising:
introducing multiple co-flow pulses of a first gas and a second gas into a processing chamber, wherein each co-flow pulse comprises a pulse of the first gas from a first gas source and a pulse of the second gas from a second gas source, wherein the pulse of the first gas and the pulse of the second gas, as measured from when each gas is
10 flowed from its it gas source, are offset and overlap in time, and wherein the each pulse of the first gas is separated from subsequent pulses of the first gas by a purge and each pulse of the second gas is separated from subsequent pulses of the second gas by a purge.

15 19. The method of claim 18, further comprising determining an offset from one or more parameters.

20. The method of claim 19, further comprising receiving the one or more parameters.

20 21. The method of claim 20, wherein the one or more parameters comprise: the identity of a gas to be delayed, the length of offset, and the whether to shorten a pulse or purge.

25 22. The method of any of claims 18–21, further comprising modifying a pulse sequence of the first gas or the second gas in accordance with the determined offset.

23. A tangible machine-readable medium comprising instructions for:
introducing multiple co-flow pulses of a first gas and a second gas into a processing chamber, wherein each co-flow pulse comprises a pulse of the first gas and a pulse of the
30 second gas, wherein the pulse of the first gas and the pulse of the second gas are offset and overlap in time, and wherein the each pulse of the first gas is separated from subsequent pulses of the first gas by a purge and each pulse of the second gas is separated from subsequent pulses of the second gas by a purge.

24. The tangible machine-readable medium of claim 23, further comprising instructions for determining an offset from one or more parameters.

25. The tangible machine-readable medium of claim 23, further comprising
5 instructions for receiving the one or more parameters from a user input.

26. The tangible machine-readable medium of claim 24, wherein the one or more parameters comprise: the identity of a gas to be delayed, the length of offset, and the whether to shorten a pulse or purge.

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27. The tangible machine-readable medium of any of claims 23–26, further comprising modifying a pulse sequence of the first gas or the second gas in accordance with the determined offset.