CLAIMS

WHAT IS CLAIMED IS:

1. A plasma-enhanced atomic layer deposition apparatus, comprising two process chambers, a precursor supply device, a reaction gas supply device, a radio frequency device, and a pressure adjustment device, wherein:

the precursor supply device communicates with gas inlet structures of the two process chambers and is configured to selectively provide a precursor or a purge gas to at least one of the two process chambers;

the reaction gas supply device communicates with the gas inlet structures of the two process chambers and is configured to selectively provide a reaction gas to at least one of the two process chambers;

the radio frequency device is connected to the two process chambers and is configured to selectively output radio frequency power to at least one of the two process chambers; and

the pressure adjustment device communicates with exhaust openings of the two process chambers and is configured to independently control chamber pressures of the two process chambers.

2. The plasma-enhanced atomic layer deposition apparatus according to claim 1, wherein the precursor supply device includes a precursor source, a gas inlet pipeline group, a switching pipeline group, and a gas pump device, wherein:

the precursor source communicates with the gas inlet pipeline group through the switching pipeline group, and the gas inlet pipeline group communicates with the gas inlet structures of the two process chambers;

the precursor source is configured to provide the precursor or purge gas;

the switching pipeline group is configured to selectively communicate the precursor source to the gas inlet pipeline group or the gas pump device; and

the gas inlet pipeline assembly is configured to selectively communicate the precursor source to at least one of the two process chambers.

3. The plasma-enhanced atomic layer deposition apparatus according to claim 2, wherein the gas inlet pipeline group includes a first gas inlet branch and a second gas inlet branch, wherein:

a gas outlet end of the first gas inlet branch and a gas outlet end of the second gas inlet branch communicate with the gas inlet structures of the two process chambers, respectively;

a gas inlet end of the first gas inlet branch and a gas inlet end of the second gas inlet branch communicate with the switching pipeline group;

a first on-off valve and a second on-off valve are arranged at the first gas inlet branch and the second gas inlet branch, respectively.

4. The plasma-enhanced atomic layer deposition apparatus according to claim 3, wherein the gas inlet pipeline group further includes a first dilution branch and a second dilution branch, wherein gas inlet ends of the first dilution branch and the second dilution branch communicate with a dilution gas source configured to provide the dilution gas, respectively, gas outlet ends of the first dilution branch and the second dilution branch communicate with a first gas inlet branch and a second gas inlet branch, respectively, and a first flow controller and a second flow controller are arranged at the first dilution branch and the second dilution branch.

5. The plasma-enhanced atomic layer deposition apparatus according to claim 3, wherein the gas inlet pipeline group further includes two gas mixing structures, wherein each of the two mixing structures has a first gas inlet end, a second gas inlet end, and a gas outlet end, the first gas inlet ends of the two mixing structures communicate with the gas outlet ends of the first gas inlet branch and the second gas inlet branch, the gas outlet ends of the two gas mixing structures communicate with the gas inlet structures of the two process chambers, respectively, and the second gas inlet ends of the two gas mixing structures communicate with a balance gas source configured to provide a balance gas and a reaction gas supply device, respectively.

6. The plasma-enhanced atomic layer deposition apparatus according to claim 5, wherein each of the mixing structures includes a gas mixing block and a gas mixing pipeline, the gas mixing block has a mixing chamber, and the first gas inlet end and the second gas inlet end are formed on an outer surface of the gas mixing block, a gas outlet end is formed on the outer surface of the gas mixing block, the gas outlet end communicates with a gas inlet end of the gas mixing pipeline, and the gas outlet end of the gas mixing pipeline is used as the gas outlet end of the gas mixing structure to communicate with the gas inlet structure of the process chamber.

7. The plasma-enhanced atomic layer deposition apparatus according to any one of claims 2 to 6, wherein the switching pipeline group includes a first switching branch and a second switching branch, two ends of the first switching branch communicate with the precursor source and the gas inlet pipeline group, respectively, two ends of the second switching branch communicate with the first switching branch and the gas pump device, and a third on-off valve

and a fourth on-off valve are arranged at the first switching branch and the second switching branch.

8. The plasma-enhanced atomic layer deposition apparatus according to any one of claims 2 to 6, wherein the precursor source includes a carrier gas main route, a source bottle, a first carrier gas branch, and a second carrier gas branch, wherein:

a gas inlet end of the carrier gas main route communicates with a carrier gas source for providing a carrier gas, a gas outlet end of the carrier gas main route communicates with the switching pipeline group, and a fifth on-off valve and a third flow controller are arranged at the carrier gas main route;

a gas inlet end of the first carrier gas branch communicates with the carrier gas main route at an upstream position of the fifth on-off valve, and a gas outlet end of the first carrier gas branch communicates with a gas inlet end of the source bottle, a gas outlet end of the second carrier gas branch communicates with the carrier gas main route at a downstream position of the fifth on-off valve, a gas inlet end of the second carrier gas branch communicates with the gas outlet end of the source bottle, and a sixth on-off valve and a seventh on-off valve are arranged at the first carrier gas branch and the second carrier gas branch; and

the source bottle is configured to store the precursor.

9. The plasma-enhanced atomic layer deposition apparatus according to claim 1, wherein the radio frequency device includes a first matcher, a second matcher, a first radio frequency generator, and a second radio frequency generator, wherein the first radio frequency generator is electrically connected to one of the process chambers through the first matcher, and

the second radio frequency generator is electrically connected to the other one of the process chambers through the second matcher.

10. The plasma-enhanced atomic layer deposition apparatus according to claim 1, wherein the pressure adjustment device includes a first exhaust branch and a second exhaust branch, wherein gas inlet ends of the first exhaust branch and the second exhaust branch communicate with exhaust openings of the two process chambers, respectively, gas outlet ends of the first exhaust branch and the second exhaust branch communicate with the gas pump device, a first isolation valve and a second isolation valve are arranged at the first exhaust branch and the second exhaust branch, respectively, and a first flow adjustment valve and a second flow adjustment valve are arranged at the first exhaust branch and the second exhaust branch.

11. The plasma-enhanced atomic layer deposition apparatus according to claim 5, wherein the plasma-enhanced atomic layer deposition apparatus further includes a remote plasma cleaning device, a first cleaning pipeline, and a second cleaning pipeline, and each of the two gas mixing structures includes a third gas inlet end, gas inlet ends of the first cleaning pipeline and the second cleaning pipeline communicate with the remote plasma cleaning device, gas outlet ends of the first cleaning pipeline and the second cleaning pipeline communicate with the two third gas inlet ends, and a third isolation valve and a fourth isolation valve are arranged at the first cleaning pipeline and the second cleaning pipeline, respectively; and

the remote plasma cleaning device is configured to provide a plasma for cleaning the process chamber.

12. A plasma-enhanced atomic layer deposition method, using the plasma-enhanced atomic layer deposition apparatus according to any one of claims 1 to 11 to simultaneously deposit film layers on two wafers, comprising:

at S1, introducing the precursor into a first process chamber of the two process chambers, introducing the reaction gas into a second process chamber of the two process chambers, and applying the radio frequency power to the second process chamber;

at S2, purging the precursor supply device and the two process chambers in the plasma-enhanced atomic layer deposition apparatus;

at S3, introducing the precursor into the second process chamber, introducing the reaction gas into the first process chamber, and applying the radio frequency power to the first process chamber;

at S4, purging the precursor supply device and the two process chambers in the plasma-enhanced atomic layer deposition apparatus; and

repeating steps S1 to S4 in a cycle until the thicknesses of the deposited film layers on the two wafers reach a target thickness.