

Description

Method for providing a process gas for a CVD reactor and related apparatus

Field of Invention

[0001] The invention relates to a method for supplying a process gas to a CVD reactor, comprising a first carrier gas supply line fed from a carrier gas source and featuring a first mass flow controller with a small flow range, and a second
5 carrier gas supply line with a second mass flow controller with a large flow range. The carrier gas supply line flows in an evaporation device for evaporating a solid or liquid source material, wherein a process gas supply line to the CVD reactor originates from the evaporation device. A valve is arranged in the second carrier gas supply line, which includes the second mass flow controller.
10 The valve has an inlet and a first outlet connected to the evaporation device. The invention further relates to a suitable device for this purpose.

State of the art

[0002] DE 10 2021 117 457 A1 describes an arrangement for supplying a process gas for use in one or more CVD reactors. A vaporization device is provided, which has a supply line through which a carrier gas can flow from a carrier gas source into a container of the vaporization device. The carrier gas supply line is connected to two mass flow controllers arranged in parallel to each
15 other, which can have different flow ranges. A shut-off valve is arranged upstream of the mass flow controller in the supply line to the controller with the wider flow range. The mass flow controller can be selectively activated by
20 means of this shut-off valve.

[0003] DE 10 2019 117 543 A1 discloses a gas mixing system for a substrate treatment device, in particular a MOCVD reactor. The carrier gas supply line is connected to a mass flow controller. Downstream of the mass flow controller, a

valve is arranged with which the supply line to the vaporization device can be closed. A further valve allows the mass flow controller to be connected to a bypass line for calibration purposes, which leads to the gas outlet of the reactor.

[0004] US 10,109,483 B2 discloses a MOCVD reactor system comprising an
5 evaporation vessel containing a liquid precursor. A carrier gas mass flow, regulated by a mass flow controller, flows from a gas source into the evaporation vessel via a carrier gas supply line. A valve is located downstream of the mass flow controller. When this valve is closed, the carrier gas can flow through a bypass line connected to the process gas supply line via a three-way valve.

10 [0005] US 2014/0083512 A1 describes a vaporization source with two feed lines, each of which can supply nitrogen to a vaporization chamber. A process gas line extends from the vaporization chamber, transporting vapor from the vaporization chamber to a process chamber of a CVD reactor. Each of the two feed lines is connected to the process gas line via a bypass line.

15 [0006] US 2017/0362701 A1 describes a vaporization source with multiple vaporization chambers that are part of a central gas supply. Each vaporization chamber has a feed line that can be connected to an outlet via a bypass line if one of the vaporization chambers needs to be changed.

[0007] DE 10 2020 103 822 A1 describes a device for vaporizing a powder,
20 wherein two supply lines open into a vaporization chamber. One of the two supply lines has a valve arrangement with which a carrier gas flow, fed into the vaporization chamber in a first operating position, can be directed around the vaporization chamber in a second operating position.

Summary of the invention

[0008] To create multiple flow ranges for a carrier gas mass flow passing through the evaporation vessel of a CVD reactor's vaporization unit, the prior art employs a parallel connection of a first mass flow controller covering a smaller flow range and a second mass flow controller covering a larger flow range. The second mass flow controller can be connected to this via an upstream valve. To reduce the carrier gas mass flow and restrict it back to the flow range of the first mass flow controller, the second mass flow controller is deactivated by the valve. For this purpose, the second mass flow controller is regulated to a minimum flow rate. The volume between the mass flow controller and the shut-off valve is maintained at an overpressure. Due to an unavoidable dead volume, a gradually decreasing carrier gas mass flow continues to flow into the vaporization vessel of the vaporization unit even after deactivation, in addition to the carrier gas mass flow passing through the first mass flow controller. This leads to a significant distortion of the gas feed into the evaporation vessel, especially with small carrier gas mass flows.

[0009] The invention is based on the task of providing measures that enable a rapid and precise switch from a high carrier gas mass flow to a low carrier gas mass flow. In particular, the invention aims to provide a method for supplying a precisely controlled process gas flow to one or more CVD reactors.

[0010] The problem is solved by the invention specified in the claims, wherein the dependent claims not only represent advantageous further developments of the technical solutions specified in the main claim, but are also independent solutions to the problem.

[0011] The invention proposes, first and foremost, that a valve arrangement, preferably a switching valve, be arranged downstream of the second mass flow

controller. The switching valve allows the carrier gas mass flow controlled by the second mass flow controller to either flow through the evaporation vessel in addition to the carrier gas mass flow controlled by the first mass flow controller, or to bypass the evaporation device. The switching valve has an inlet
5 through which the carrier gas mass flow controlled by the second mass flow controller enters. The carrier gas mass flow can either flow out of the switching valve through a first outlet and into the evaporation device, or out of the switching valve through a second outlet and bypass the evaporation device. The second outlet can be connected to a bypass line. The bypass line can be connected to the gas outlet of an evaporation vessel of the evaporation device or directly to one or more process gas supply lines leading into one or more CVD reactors.
10

[0012] The valve arrangement can comprise two valves. A first valve can be located downstream of the second mass flow controller, and a second valve can
15 be located in the bypass line. The bypass line can branch off from a section of the second carrier gas supply line located downstream of the second mass flow controller and upstream of the first valve. The valves can be selectively opened or closed. In a first process step, the first valve is open, and the second valve is closed. In a second process step, the first valve is closed, and the second valve is
20 open. It is designed so that the carrier gas mass flow controlled by the second mass flow controller cannot flow simultaneously through the evaporation vessel and the bypass line.

[0013] To prevent the first and second valves from opening simultaneously, they can be switched with a time delay. When switching from the first to the
25 second process step, the first valve can be closed first, followed by the opening of the second valve after a time delay. Similarly, when switching from the

second to the first process step, the second valve can be closed first, followed by the opening of the first valve after a time delay.

[0014] To prevent the carrier gas mass flow passing through the first mass flow controller from briefly bypassing the evaporation unit, for example into
5 the bypass line, during the switchover between the two process steps, the valves can have throttle orifices. These throttle orifices can be designed such that a certain pressure differential between the inlet and outlet pressures of the valve is maintained during the switchover between the first and second process steps. This prevents the carrier gas mass flow controlled by the first mass flow
10 controller from bypassing the evaporation unit and flowing through the bypass line. The cross-sectional constriction of the throttle orifices can be variable. This constriction can be achieved by means of a throttling device, such as a flap. The throttle valve can be an electric throttle valve. The cross-sectional constriction can be controlled by a control device. Alternatively, the throttle valve can be
15 manually operated. Furthermore, the throttle valve can be pneumatically actuated. The throttle valve can be, for example, a screw-in throttle valve or a butterfly valve.

[0015] With a preferably electronic pressure regulator, the total pressure within the gas mixing system can be kept constant during the switchover be-
20 tween the first and second process steps of the switching valve. The use of a switching valve allows the carrier gas mass flow to be kept permanently active by the second mass flow controller, thus preventing its deactivation. This prevents significant deviations between the actual and target values of the carrier gas mass flow through the evaporation vessel during the switching process. As
25 a result of the arrangement according to the invention, the pressure regulator has to compensate for smaller fluctuations in the total carrier gas mass flow through the evaporation vessel during the switching process, since the total

flow at the gas outlet does not change due to the reintroduction of the carrier gas mass flow bypassing the evaporation unit.

[0016] The mass flow controllers feature a control loop that regulates the mass flow according to a predefined setpoint. The mass flow controllers can be operated with different setpoints. For example, the setpoint can be decreased or increased gradually. This is preferably controlled by a control unit. The setpoints can be provided, for example, by a recipe. The changeover valve can also be controlled by a control unit.

[0017] By selectively switching several mass flow controllers with different flow ranges, connected in parallel, into the carrier gas mass flow through the evaporation vessel, a large flow range can be covered.

[0018] The one or more mass flow controllers connected in parallel form a mass flow control device. The mass flow control device is arranged upstream of an evaporation vessel of the evaporation unit, containing a liquid or solid source material, for example, a metal-organic compound for layer deposition consisting of GaN , GaAs , InP , and/or SiC . This source material is converted into a vapor by heating and transported with the carrier gas mass flow into a CVD reactor. The evaporation vessel can be temperature-controlled. It can be provided that the evaporation vessel is continuously refilled from a storage container.

[0019] In one embodiment of the invention, the carrier gas mass flow supplied by a carrier gas source is divided among several mass flow control devices, each of which is connected to an evaporation unit. From each mass flow control device, the carrier gas mass flow is directed into an evaporation vessel. Alternatively, the carrier gas mass flow can be partially routed past the evaporation

vessel. The carrier gas mass flow conveys the vapor generated in the evaporation vessel from a gas outlet of the evaporation unit into a process gas supply line. The process gas supply line leads into one or more process chambers of one or more CVD reactors.

- 5 [0020] In a further embodiment of the invention, a mass flow of carrier gas from several different carrier gas sources flows into one or more different mass flow control devices, each of which can be connected to an evaporation device. Thus, different carrier gases can be used. The carrier gas can be an inert gas, for example nitrogen or hydrogen.
- 10 [0021] The device described above allows the carrier gas mass flow from a carrier gas source to be switched from a high to a low mass flow through a vaporization unit. The carrier gas mass flow from the carrier gas source flows through the mass flow control device. Within the mass flow control device, the carrier gas mass flow is divided between at least two mass flow controllers, with the
- 15 carrier gas mass flow continuously flowing through both. By closing the first valve and opening the second valve of the switching valve, the carrier gas mass flow flowing through the second mass flow controller can bypass the vaporization unit located downstream of the mass flow control device by entering the bypass line. As a result, the carrier gas mass flow flowing through the vaporiza-
- 20 tion unit's vaporization vessel is then controlled only by the first mass flow controller, which can have a smaller flow range than the second mass flow controller. From the bypass line, the carrier gas mass flow is conveyed into the process gas supply line. During the switching process, the opening/closing of the first valve can be delayed relative to the opening/closing of the second valve to en-
- 25 sure that both valves are not open simultaneously. This prevents the carrier gas mass flow through the first mass flow controller from flowing directly into the

process gas supply line via the bypass line, instead of first flowing through the evaporation vessel as intended.

[0022] The inventive method enables switching between high and low carrier flows during operation of the CVD reactor, for example during a layer growth process. For this purpose, the switching time is minimized such that the layer composition does not change uncontrollably during the switching process.

Brief description of the drawings

[0023] The invention is explained in detail below with reference to the accompanying drawings. These show:

- Fig. 1 shows a circuit diagram of a first embodiment in which a CVD reactor 1 is fed by a process gas supply system 19,
- Fig. 2 a circuit diagram of a second embodiment of the invention, in which a process gas supply system 19 feeds several CVD reactors,
- Fig. 3 a circuit diagram of a third embodiment in which a CVD reactor 1 is fed by a plurality of process gas supply systems 19, 19', 19'',
- Fig. 4 a circuit diagram of a fourth embodiment of a process gas supply system 19, in which a central carrier gas supply line is connected to several process gas supply systems, each of which feeds a CVD reactor 1.

Description of the embodiments

[0024] In the process gas supply systems 19, 19', 19'' shown in Figures 1 to 4, a carrier gas is fed into an evaporation vessel 17 of an evaporation device 6. The carrier gas, for example nitrogen, hydrogen or a noble gas, becomes saturated with the vapor of the solid or liquid source material 24 stored in the evaporation vessel 17 and leaves the evaporation vessel 17 through a discharge.

[0025] The inlet and outlet of the evaporation vessel 17 are connected to a switching device 18 which has several valves that can be switched such that a carrier gas mass flow supplied by a mass flow control arrangement consisting of one or more mass flow controllers 3, 5, 5' either flows through the evaporation vessel or past the evaporation vessel.

[0026] In the embodiments shown in Figures 1 to 4, one or more process gas supply lines 7, into which the vapor of a source material 24 conveyed by the carrier gas mass flow from the evaporation device 6 is fed, lead into one or more CVD reactors 1, 1', 1''.

[0027] The process gas supply systems 19, 19', 19'' are used to provide a metal-organic source material 24 for a CVD reactor 1, 1', 1'' in which one or more substrates 20 rest on a heated susceptor 21 forming the bottom of a process chamber 22.

[0028] The embodiments show a pressure regulator 16. The pressure regulator keeps the total pressure in the process gas supply system 19, 19', 19'' constant.

[0029] The arrangement shown in Figure 1 for supplying a process gas comprises two mass flow controllers 3, 5 connected in parallel, which have different flow ranges, for example, differing by a factor of at least 2, 5, or 10. The mass

flow controllers 3, 5, 5' regulate the carrier gas mass flow into the evaporation unit 6. The first mass flow controller 3 can have a smaller flow range, for example, 100 standard cubic centimeters, than the second mass flow controller 5, which can have a flow range of, for example, 1000 standard cubic centimeters.

5 The first mass flow controller 3 is arranged in a first carrier gas supply line 2, and the second mass flow controller 5 is arranged in a second carrier gas supply line 4. The carrier gas supply lines 2, 4 are connected to a central carrier gas source (not shown). From the carrier gas source, a first carrier gas mass flow passes through the first carrier gas supply line 2 and a second carrier gas mass
10 flow passes through the second carrier gas supply line 4 into the evaporation unit 6. The first carrier gas mass flow, provided by the first mass flow controller 3, is continuously fed into the evaporation unit. A valve arrangement 8, located downstream of the second mass flow controller 5 and in particular a switching valve, allows the second carrier gas mass flow provided by the second mass
15 flow controller 5 to be selectively fed either into the evaporation unit 6 or into a bypass line 12. For this purpose, the valve arrangement 8 comprises a first valve 13 and a second valve 14. The first valve 13 is located in the second carrier gas supply line 4. The second valve 14 is located in the bypass line 12. The bypass line 12 branches off upstream of the first valve 13 and opens into the process
20 gas supply line 7 downstream of the evaporation vessel 17. A mass flow controller 15 is located in the process gas supply line 7, which regulates the mass flow of the process gas fed into the CVD reactor 1 through the process gas supply line 7. With such a device, the carrier gas mass flow fed into the evaporation device can be switched quickly and precisely, in particular from a high carrier
25 gas mass flow to a low carrier gas mass flow, since the total mass flow of the gas flowing through the process gas supply line remains constant. This ensures that the total pressure within the process gas supply system 19, as measured by a pressure regulator 16, remains constant.

[0030] In another variant of the invention, a switching valve can also be arranged in the first carrier gas supply line 2.

[0031] Figure 2 shows a further embodiment as a variant of the embodiment shown in Figure 1. Here, a second mass flow controller 5' is arranged parallel to the first mass flow controller 3 and the second mass flow controller 5'. This second mass flow controller has a flow range that is larger than the flow range of the first mass flow controller 3, but different from the flow range of the second mass flow controller 5. For example, the mass flow controller 5 can have a flow range that is at least twice as large as that of the mass flow controller 3, and the mass flow controller 5' can have a flow range that is at least twice as large as that of the mass flow controller 5. This expands the flow range of the carrier gas mass flowing into the evaporation device. Furthermore, the mass flow of the process gas splits into several partial flows, each of which is directed to different CVD reactors 1, 1', 1'', with each process gas supply line 7, 7', 7'' leading to a CVD reactor 1, 1', 1'' being assigned an individual mass flow controller 15, 15', 15''.

[0032] The embodiment shown in Figure 3 is a variant of the embodiment shown in Figure 1. Here, a CVD reactor is connected to several different process gas supply systems 19, 19', 19''. The process gas supply systems 19, 19', 19'' can be fed from different carrier gas sources or a central carrier gas source. The mass flow of the process gas flowing through the process gas supply lines 7, 7', 7'' can be controlled by a mass flow controller 15, 15', 15''. The process gas mass flows enter a gas inlet of a CVD reactor 1, and the process gases can exit from different gas inlet openings of the gas inlet.

[0033] In the embodiment shown in Figure 4, three process gas supply lines 7, 7', 7'', each connected to different process gas supply systems 19, 19', 19'', open

into a gas inlet opening 23 of a CVD reactor 1, 1', 1''. The process gas supply systems 19, 19', 19'' are fed from a central carrier gas source.

[0034] The foregoing statements serve to explain the inventions covered by the application as a whole, which each independently further develop the prior art
5 at least through the following combinations of features, whereby two, several or all of these combinations of features may also be combined, namely:

[0035] An arrangement characterized in that the valve arrangement 8, 8' is arranged downstream of the second mass flow controller 5, 5' and has a second outlet 11, 11' in flow connection with a bypass line 12, 12' which does not open
10 into the evaporation device 6, wherein by switching the valve arrangement 8, 8' the carrier gas mass flow controlled by the second mass flow controller 5, 5' is selectively directed either through the evaporation device 6 or past the evaporation device 6.

[0036] An arrangement characterized in that the valve arrangement 8, 8' is a
15 switching valve comprising a first valve 13, 13' arranged in the second carrier gas supply line 4, 4' and a second valve 14, 14' arranged in the bypass line 12, 12'.

[0037] An arrangement characterized in that the bypass line 12 leads into the process gas supply line 7.

20 [0038] An arrangement characterized in that the valves 13, 13', 14, 14' of the switching valve 8, 8' have throttle openings designed such that when the switching valve 8, 8' is switched a positive pressure difference is maintained between an inlet pressure and an outlet pressure of the first valve 13, 13', 14, 14', so that a carrier gas mass flow controlled by the first mass flow controller 3 is

not directed past the evaporation device 6, wherein the cross-section of the throttle openings can be variably controlled.

[0039] An arrangement characterized in that a control device is provided which controls the switching valve 8, 8' and the mass flow controllers 3, 5, 5'.

5 [0040] A CVD reactor arrangement characterized by an arrangement for providing a process gas according to one of the preceding claims.

[0041] A method for providing a process gas, wherein a first mass flow controller 3 provides a first carrier gas mass flow and a second mass flow controller 5, 5' provides a second carrier gas mass flow, wherein in a first process step at least the second carrier gas mass flow flows through the evaporation device 6 and in a second process step the first carrier gas mass flow flows through the evaporation device 6 and the second carrier gas mass flow flows past the evaporation device 6, wherein the total carrier gas mass flow flowing through the evaporation device 6 is greater in the first process position than in the second process position.

10
15

[0042] A method characterized in that the first carrier gas flow passes through a first carrier gas supply line 2 and the second carrier gas flow passes through a second carrier gas supply line 4, 4', wherein by closing a first valve 13, 13' arranged in the second carrier gas supply line 4, 4' and opening a second valve 14, 14' arranged in a bypass line 12, 12' branching off from the second carrier gas supply line 4, 4' the carrier gas mass flow controlled by the second mass flow regulator 5, 5' flows through the bypass line 12, 12' and by opening the first valve 13, 13' and closing the second valve 14, 14' the carrier gas mass flow passes through the second carrier gas supply line 4, 4' into the evaporation device 6.

20
25

[0043] A method characterized in that the first valve 13, 13' and the second valve 14, 14' are switched with a time delay, wherein when switching from the first process step to the second process step the first valve 13, 13' is closed and subsequently the second valve 14, 14' is opened, and when switching from the
5 second process step to the first process step the second valve 14, 14' is closed and subsequently the first valve 13, 13' is opened.

[0044] All disclosed features are essential to the invention (individually, but also in combination with one another). The disclosure of this application hereby incorporates in full the disclosure content of the associated/attached priority
10 documents (copy of the prior application), also for the purpose of including features of these documents in the claims of the present application. The dependent claims characterize , even without the features of a referenced claim, independent inventive developments of the prior art, in particular for the purpose of filing divisional applications based on these claims. The invention specified
15 in each claim may additionally include one or more of the features described above, in particular those identified by reference numerals and/or listed in the reference numeral list. The invention also relates to designs in which individual features mentioned in the preceding description are not implemented, in particular insofar as they are recognizably unnecessary for the respective purpose or
20 can be replaced by other technically equivalent means.

List of reference symbols

1	CVD reactor	14'	Second valve
1'	CVD reactor	15	Mass flow controllers
1''	CVD reactor	15'	Mass flow regulator
2	Carrier gas supply line	15''	Mass Flow Controller
3	First mass flow controller	16	Pressure regulators
4	Carrier gas supply line	17	Evaporation container
4'	Carrier gas supply line	19	Process gas supply system
5	Second mass flow controller	19'	Process gas supply system
5'	Second mass flow controller	19''	Process gas supply system
6	Evaporation device	20	Substrate
7	Process gas supply line	21	Susceptor
7'	Process gas supply line	22	Process chamber
7'	Process gas supply line	23	Gas inlet opening
7''	Process gas supply line	24	Liquid source material
8	Valve arrangement		
8'	Valve arrangement		
9	Entrance		
9'	Entrance		
10	First exit		
10'	First exit		
11	Second exit		
11'	Second exit		
12	Bypass line		
12'	Bypass line		
13	First valve		
13'	First valve		
14	Fecond valve		

Claims

1. Method for providing a process gas for a CVD reactor (1, 1', 1'') wherein a first carrier gas supply line (2) and a second carrier gas supply line (4) lead into an evaporation device (6) for evaporating a solid or liquid source material, wherein a process gas supply line (7) to the CVD reactor (1, 1', 1'')
5 originates from the evaporation device (6), wherein a first mass flow controller (3) with a small flow range is arranged in the first carrier gas supply line (2) and a second mass flow controller (5, 5') with a large flow range is arranged in the second carrier gas supply line (4, 4'), wherein a solid or liquid source material is evaporated in the evaporation device (6), wherein in
10 a first process step a first mass flow of a carrier gas fed from a carrier gas source into the first carrier gas supply line (2) and a second mass flow of the carrier gas fed from the carrier gas source into the second carrier gas supply line (4, 4') controlled by the second mass flow controller (5, 5') flow through the evaporation device (6) into the process gas supply line (7),
15 wherein in a second process step only the first mass flow regulated by the first mass flow controller (3) flows into the evaporation device (6) and the second mass flow is routed past the evaporation device (6) via a bypass line (12, 12') and conveyed into the process gas supply line (7), wherein the total carrier mass flow flowing through the evaporation device (6) in the
20 first process step is greater than in the second process step.
2. Method according to claim 1, characterized in that when switching from the first process step to the second process step, a first valve (13, 13') arranged in the second carrier gas supply line (4, 4') is closed and a second valve (14, 14') arranged in the bypass line (12, 12') branching off from the
25 second carrier gas supply line (4, 4') is closed.

3. Method according to one of the preceding claims, characterized in that the first valve (13, 13') and the second valve (14, 14') are switched with a time delay, wherein first the first valve (13, 13') is closed and subsequently the second valve (14, 14') is opened.
- 5 4. Method according to one of the preceding claims, characterized in that when switching from the second process step to the first process step, the second valve is first closed and subsequently the first valve (13, 13') is opened.
- 10 5. Method according to one of the preceding claims, characterized in that a variable cross-sectional narrowing of a throttle opening in the valves (13, 13', 14, 14') prevents the first mass flow controlled by the first mass flow controller (3) from flowing into the bypass line (12, 12') when switching between the first and the second method step.
- 15 6. Apparatus for carrying out a method according to one of the preceding claims with a first carrier gas supply line (2) with a first mass flow controller (3, 3') having a small flow range and with a second carrier gas supply line (4, 4') with a second mass flow controller (5, 5') having a large flow range, each supplied by a carrier gas source and controlled by a control device, wherein the carrier gas supply lines (2, 4, 4') lead into an evaporation device (6) for evaporating a solid or liquid source material, wherein a process gas supply line (7) to a CVD reactor (1, 1', 1'') originates from the evaporation device (6), wherein a valve arrangement (8, 8') controlled by the control device is arranged in the second carrier gas supply line (4, 4') downstream of the second mass flow controller (5, 5'), which has an inlet
20 (9, 9'), a first outlet (10, 10') flow-connected to the evaporation device (6) and a second outlet (11, 11'), characterized in that the second outlet (11,
25

11') is connected to a bypass line (12, 12') which is routed past the evaporation device (6) and leads into the process gas supply line (7).

7. Device according to claim 6, characterized in that the control device is configured to carry out a method according to one of claims 1 to 5.
- 5 8. Device according to claim 6 or 7, characterized in that the valve arrangement (8, 8') is a switching valve comprising a first valve (13, 13') arranged in the second carrier gas supply line (4, 4') and a second valve (14, 14') arranged in the bypass line (12, 12').
9. Device according to claim 6, 7 or 8, characterized in that the valves (13, 13',
10 14, 14') of the switching valve (8, 8') have throttle openings designed such that when the switching valve (8, 8') is switched a positive pressure difference between an inlet pressure and an outlet pressure is maintained at the first valve (13, 13') or at the second valve (14, 14'), so that a carrier gas mass flow controlled by the first mass flow controller (3) is not directed
15 past the evaporation device (6).
10. Device for carrying out a method according to one of claims 1 to 5, comprising a first carrier gas supply line (2) with a first mass flow controller (3, 3') having a small flow range and with a second carrier gas supply line (4, 4') with a second mass flow controller (5, 5') having a large flow range,
20 wherein the carrier gas supply lines (2, 4, 4') lead into an evaporation device (6) for evaporating a solid or liquid source material, wherein a process gas supply line (7) to a CVD reactor (1, 1', 1'') originates from the evaporation device (6), wherein a valve arrangement (8, 8') controlled by a control device is arranged in the second supply line (4, 4') downstream of
25 the second mass flow controller (5, 5'), which has an inlet (9, 9'), a first

outlet (10, 10') flow-connected to the evaporation device (6) and a second outlet (11, 11'), wherein the second outlet (11, 11') is flow-connected to a bypass line (12, 12'), which is guided past the evaporation device (6) and leads into the process gas supply line (7), characterized in that the valves (13, 13', 14, 14') of the switching valve (8, 8') have variably controllable throttle openings.

11. Method or device characterized by one or more of the characterizing features of one of the preceding claims.