substrate transfers in the required time. In other words, with too many required substrate transfers between reaction chambers in a reactor system during a processing method, there may be a substrate "traffic jam," causing delays in substrate transfers between reaction chambers relative to the desired timing of such substrate transfers and subsequent processing step(s). Therefore, a substrate in a certain reaction chamber of a reactor system (such as reactor system 90 or 91) may be required to remain in a reaction chamber after the process step in such a reaction chamber is complete, before being transferred to another reaction chamber. Such waiting may decrease the efficiency of a reactor system to produce finished products (e.g., semiconductors) and/or may diminish the quality of the finished products.

SUMMARY OF THE DISCLOSURE

[0004] This summary is provided to introduce a selection of concepts in a simplified form. These concepts are described in further detail in the detailed description of example examples of the disclosure below. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0004A] In accordance with a first aspect of the present disclosure, there is provided a reactor system. The reactor system includes a first reaction chamber, a first reaction chamber first gate valve coupled to the first reaction chamber and configured to allow transferring a substrate at least one of into or out of the first reaction chamber, and a first transfer chamber. The first transfer chamber is in fluid communication with the first reaction chamber via the first reaction chamber first gate valve in response to the first reaction chamber first gate valve being opened. The reactor system is configured to allow transfer of the substrate between the first reaction chamber and the first transfer chamber through the opened first reaction chamber first gate valve. The reactor system further includes a first reaction chamber second gate valve coupled to the first reaction chamber and configured to allow transferring a substrate at least one of

into or out of the first reaction chamber, and a second transfer chamber in fluid communication with the first reaction chamber via the first reaction chamber second gate valve in response to the first reaction chamber second gate valve being opened. The reactor system is configured to allow transfer of the substrate between the first reaction chamber and the second transfer chamber through the opened first reaction chamber second gate valve. The reactor system further includes a second reaction chamber, and a second reaction chamber first gate valve coupled to the second reaction chamber and configured to allow transferring the substrate at least one of into or out of the second reaction chamber. The second reaction chamber is in fluid communication with the second transfer chamber via the second reaction chamber first gate valve in response to the second reaction chamber first gate valve being opened. The reactor system further includes a third transfer chamber and a second reaction chamber second gate valve coupled to the second reaction chamber. The second reaction chamber is in fluid communication with the third transfer chamber via the second reaction chamber second gate valve in response to the second reaction chamber second gate valve being opened. The reactor system further includes a third reaction chamber, and a third reaction chamber first gate valve coupled to the third reaction chamber and configured to allow transferring the substrate at least one of into or out of the third reaction chamber. The third reaction chamber is in fluid communication with the third transfer chamber via the third reaction chamber first gate valve in response to the third reaction chamber first gate valve being opened. The reactor system further includes a third reaction chamber second gate valve coupled to the third reaction chamber. The third reaction chamber is in fluid communication with at least one of the first transfer chamber or the second transfer chamber via the third reaction chamber second gate valve in response to the third reaction chamber second gate valve being opened. The reactor system further includes a first reactor system including the first reaction chamber, a first reactant source including a first reactant disposed therein, a first distribution system

configured to distribute the first reactant to the first reaction chamber, and a first controller configured to supply the first reactant to the substrate in the first reaction chamber via the first distribution system for a first duration before transferring the substrate from the first reaction chamber, a second reactor system including the second reaction chamber, a second reactant source including a second reactant disposed therein, a second distribution system configured to distribute the second reactant to the second reaction chamber, and a second controller configured to supply the second reactant to the substrate in the second reaction chamber via the second distribution system for a second duration before transferring the substrate from the second reaction chamber, and a third reactor system including the third reaction chamber, a third reactant source including a third reactant disposed therein, a third distribution system configured to distribute the third reactant to the third reaction chamber, and a third controller configured to supply the third reactant to the substrate in the third reaction chamber via the third distribution system for a third duration before transferring the substrate from the third reaction chamber. The first reactant is different from the second reactant and the third reactant, the second reactant and the third reactant are the same, the first duration is different from the second duration and the third duration, and the second duration and the third duration are the same.

[0004B] In accordance with a second aspect of the present disclosure, there is provided a reactor system. The reactor system includes a plurality of reaction chambers. Each of the plurality of reaction chambers includes a local controller and a reactant source including a reactant disposed therein. The local controller is configured to supply the reactant source for a set duration. The set duration that the reactant source is supplied to a first respective reaction chamber of the plurality of reaction chambers is different from the set duration that the reactant source is supplied to a second respective reaction chamber and a third respective reaction chamber of the plurality of reaction chambers. The set duration that the reactant source is supplied to the

second respective reaction chamber of the plurality of reaction chambers is the same as the set duration that the reactant source is supplied to the third respective reaction chamber of the plurality of reaction chambers. The reactant disposed in the reactant source of the first respective reaction chamber of the plurality of reaction chambers is different than the reactant disposed in the reactant source of the second respective reaction chamber and the third respective reaction chamber of the plurality of reaction chambers. The reactant disposed in the reactant source of the second respective reaction chamber of the plurality of reaction chambers is the same as the reactant disposed in the reactant source of the third respective reaction chamber of the plurality of reaction chambers. The reactor system further includes a plurality of transfer chambers, and at least two gate valves coupled to each reaction chamber of the plurality of reaction chambers. A first gate valve of the at least two gate valves fluidly couples the first respective reaction chamber of the plurality of reaction chambers to a first transfer chamber of the plurality of transfer chambers when opened, and a second gate valve of the at least two gate valves fluidly couples the first respective reaction chamber to a second transfer chamber of the plurality of transfer chambers when opened.

[0004C] In accordance with a third aspect of the present disclosure, there is provided a method. The method includes transferring a first substrate to a first reaction chamber through a first reaction chamber first gate valve coupled to the first reaction chamber, via a first transfer tool comprised in a first transfer chamber. The first reaction chamber and the first transfer chamber are in fluid communication in response to the first reaction chamber first gate valve being opened. The method further includes transferring the first substrate from the first reaction chamber through a first reaction chamber second gate valve coupled to the first reaction chamber, via a second transfer tool comprised in a second transfer chamber. The second transfer chamber is in fluid communication with the first reaction chamber in response to the first reaction chamber second gate valve being opened. The method further includes

transferring, via the second transfer tool, the substrate to a second reaction chamber through a second reaction chamber first gate valve coupled to the second reaction chamber. The second reaction chamber is in fluid communication with the second transfer chamber in response to the second reaction chamber first gate valve being opened. The method further includes transferring the substrate from the second reaction chamber, applying a first material to the substrate in the first reaction chamber for a first duration before the transferring the substrate from the first reaction chamber, and applying a second material to the substrate in the second reaction chamber for a second duration before the transferring the substrate from the second reaction chamber. The transferring the substrate from the second reaction chamber is completed via a third transfer tool comprised in a third transfer chamber and through a second reaction chamber second gate valve coupled to the second reaction chamber, wherein the second reaction chamber and the third transfer chamber are in fluid communication in response to the second reaction chamber second gate valve being opened. The method further includes transferring, via the third transfer tool, the substrate to a third reaction chamber through a third reaction chamber first gate valve coupled to the third reaction chamber. The third reaction chamber is in fluid communication with the third transfer chamber in response to the third reaction chamber first gate valve being opened. The method further includes applying a third material to the substrate in the third reaction chamber for a third duration. The second material and the third material are the same, the first duration is different from the second duration and the third duration, and the second duration and the third duration are the same.

[0005] In various examples, a reactor system is provided. The reactor system disclosed herein may comprise a plurality of reaction chambers; a plurality of transfer chambers; and/or at least two gate valves coupled to each reaction chamber of the plurality of reaction chambers. A first gate valve of the at least two gate valves may fluidly couple a first respective reaction

chamber of the plurality of reaction chambers to a first transfer chamber of the plurality of transfer chambers, and a second gate valve of the at least two gate valves may fluidly couple the first respective reaction chamber to a second transfer chamber of the plurality of transfer chambers. In various examples, each of the plurality of transfer chambers may comprise a transfer tool, wherein each transfer tool may be configured to transfer a substrate into and/or out of multiple (e.g., at least two, or a maximum of two) of the plurality of reaction chambers.

[0006] In various examples, a reactor system may comprise a first reaction chamber; a first reaction chamber first gate valve coupled to the first reaction chamber and configured to allow transferring a substrate into and/or out of the first reaction chamber; a first transfer chamber, wherein the first transfer chamber may be in fluid communication with the first reaction chamber via the first reaction chamber first gate valve in response to the first reaction chamber first gate valve being open, wherein the reactor system may be configured to allow transfer of the substrate between the first reaction chamber and the first transfer chamber through the first reaction chamber first gate valve; a first reaction chamber second gate valve coupled to the first reaction chamber and configured to allow transferring a substrate into and/or out of the first reaction chamber; and/or a second transfer chamber in fluid communication with the first reaction chamber via of the first reaction chamber second gate valve in response to the first reaction chamber second gate valve being open, wherein the reactor system may be configured to allow transfer of the substrate between the first reaction chamber and the second transfer chamber through the first reaction chamber second gate valve.

[0007] In various examples, the first transfer chamber and the second transfer chamber may be on opposite sides of the first reaction chamber from one another. In various examples, the first transfer chamber and the second transfer chamber may be disposed less than 180 degrees about the first reaction chamber from one another.

[0008] In various examples, a reactor system may further comprise a second reaction chamber; and a second reaction chamber first gate valve coupled to the second reaction chamber and configured to allow transferring the substrate into and/or out of the second reaction chamber. The second reaction chamber may be in fluid communication with the second transfer chamber via the second reaction chamber first gate valve in response to the second reaction chamber first gate valve being open. In various examples, a reactor system may further comprise a second reaction chamber second gate valve coupled to the second reaction chamber. The

second reaction chamber may be in fluid communication with the first transfer chamber via the second reaction chamber second gate valve in response to the second reaction chamber second gate valve being open.

[0009] In various examples, a reactor system may further comprise a third transfer chamber; and/or a second reaction chamber second gate valve coupled to the second reaction chamber. The second reaction chamber may be in fluid communication with the third transfer chamber via the second reaction chamber second gate valve in response to the second reaction chamber second gate valve being open.

[0010] In various examples, a reactor system may further comprise a third reaction chamber; and/or a third reaction chamber first gate valve coupled to the third reaction chamber and configured to allow transferring the substrate into and/or out of the third reaction chamber. The third reaction chamber may be in fluid communication with the third transfer chamber via the third reaction chamber first gate valve in response to the third reaction chamber first gate valve being open.

[0011] In various examples, a reactor system may further comprise a third reaction chamber second gate valve coupled to the third reaction chamber. The third reaction chamber may be in fluid communication with at least one of the first transfer chamber or the second transfer chamber via the third reaction chamber second gate valve in response to the third reaction chamber second gate valve being open. In various examples, a reactor system may further comprise a fourth transfer chamber; and/or a third reaction chamber third gate valve coupled to the third reaction chamber. The third reaction chamber may be in fluid communication with the fourth transfer chamber via the third reaction chamber third gate valve in response to the third reaction chamber third gate valve being open.

[0012] In various examples, a reactor system may further comprise a fourth transfer chamber; and/or a third reaction chamber second gate valve coupled to the third reaction chamber. The

third reaction chamber may be in fluid communication with the fourth transfer chamber via the third reaction chamber second gate valve in response to the third reaction chamber second gate valve being open. In various examples, a reactor system may further comprise a first reaction chamber third gate valve coupled to the first reaction chamber. The fourth transfer chamber may be in fluid communication with the first reaction chamber via the first reaction chamber third gate valve in response to the first reaction chamber third gate valve being open.

[0013] In various examples, a reactor system may further comprise a fourth reaction chamber; and/or a fourth reaction chamber first gate valve coupled to the fourth reaction chamber and configured to allow transferring the substrate into and/or out of the fourth reaction chamber. The fourth reaction chamber may be in fluid communication with the fourth transfer chamber via the fourth reaction chamber first gate valve in response to the fourth reaction chamber first gate valve being open. In various examples, a reactor system may further comprise a fourth reaction chamber second gate valve coupled to the fourth reaction chamber. The fourth reaction chamber may be in fluid communication with the first transfer chamber via the fourth reaction chamber second gate valve in response to the fourth reaction chamber second gate valve being open.

[0014] In various examples, a method may comprise transferring a first substrate to a first reaction chamber through a first reaction chamber first gate valve coupled to the first reaction chamber, via a first transfer tool comprised in a first transfer chamber, wherein the first reaction chamber and the first transfer chamber may be in fluid communication in response to the first reaction chamber first gate valve being opened; transferring the first substrate from the first reaction chamber through a first reaction chamber second gate valve coupled to the first reaction chamber, via a second transfer tool comprised in a second transfer chamber, wherein the second transfer chamber may be in fluid communication with the first reaction chamber in response to the first reaction chamber second gate valve being opened; transferring, via the

second transfer tool, the substrate to a second reaction chamber through a second reaction chamber first gate valve coupled to the second reaction chamber, wherein the second reaction chamber may be in fluid communication with the second transfer chamber in response to the second reaction chamber first gate valve being opened; and/or transferring the substrate from the second reaction chamber. In various examples, the transferring the substrate from the second reaction chamber may be completed via the first transfer tool through a second reaction chamber second gate valve coupled to the second reaction chamber, wherein the second reaction chamber and the first transfer chamber may be in fluid communication in response to the second reaction chamber second gate valve being opened.

[0015] In various examples, the method may further comprise applying a first material to the substrate in the first reaction chamber for a first duration before the transferring the substrate from the first reaction chamber; and/or applying a second material to the substrate in the second reaction chamber for a second duration before the transferring the substrate from the second reaction chamber. The first duration and the second duration may be the same.

[0016] In various examples, transferring the substrate from the second reaction chamber may be completed via a third transfer tool comprised in a third transfer chamber and through a second reaction chamber second gate valve coupled to the second reaction chamber, wherein the second reaction chamber and the third transfer chamber may be in fluid communication in response to the second reaction chamber second gate valve being opened. In various examples, the method may further comprise applying a first material to the substrate in the first reaction chamber for a first duration before the transferring the substrate from the first reaction chamber; applying a second material to the substrate in the second reaction chamber for a second duration before the transferring the substrate from the second reaction chamber; transferring, via the third transfer tool, the substrate to a third reaction chamber through a third reaction chamber first gate valve coupled to the third reaction chamber, wherein the third

reaction chamber is in fluid communication with the third transfer chamber in response to the third reaction chamber first gate valve being opened; and/or applying a third material to the substrate in the third reaction chamber for a third duration. In various examples, the second material and the third material may be the same, and the first duration, the second duration, and the third duration may be the same.

[0017] For the purpose of summarizing the disclosure and the advantages achieved over the prior art, certain objects and advantages of the disclosure have been described herein above. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular example of the disclosure. Thus, for example, those skilled in the art will recognize that the examples disclosed herein may be carried out in a manner that achieves or optimizes one advantage or group of advantages as taught or suggested herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

[0018] All of these examples are intended to be within the scope of the disclosure. These and other examples will become readily apparent to those skilled in the art from the following detailed description of certain examples having reference to the attached figures, the disclosure not being limited to any particular example(s) discussed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The subject matter of the present disclosure is particularly pointed out and distinctly claimed in the concluding portion of the specification. A more complete understanding of the present disclosure, however, may best be obtained by referring to the detailed description and claims when considered in connection with the drawing figures, wherein like numerals denote like elements.

[0020] FIG. 1 illustrates a schematic diagram of a reactor system, in accordance with various embodiments.

CLAIMS

What is claimed is:

1. A reactor system, comprising:

a first reaction chamber;

a first reaction chamber first gate valve coupled to the first reaction chamber and configured to allow transferring a substrate at least one of into or out of the first reaction chamber;

a first transfer chamber, wherein the first transfer chamber is in fluid communication with the first reaction chamber via the first reaction chamber first gate valve in response to the first reaction chamber first gate valve being opened, wherein the reactor system is configured to allow transfer of the substrate between the first reaction chamber and the first transfer chamber through the opened first reaction chamber first gate valve;

a first reaction chamber second gate valve coupled to the first reaction chamber and configured to allow transferring a substrate at least one of into or out of the first reaction chamber;

a second transfer chamber in fluid communication with the first reaction chamber via the first reaction chamber second gate valve in response to the first reaction chamber second gate valve being opened, wherein the reactor system is configured to allow transfer of the substrate between the first reaction chamber and the second transfer chamber through the opened first reaction chamber second gate valve;

a second reaction chamber;

a second reaction chamber first gate valve coupled to the second reaction chamber and configured to allow transferring the substrate at least one of into or out of the second reaction chamber, wherein the second reaction chamber is in fluid communication with the second

transfer chamber via the second reaction chamber first gate valve in response to the second reaction chamber first gate valve being opened;

a third transfer chamber;

a second reaction chamber second gate valve coupled to the second reaction chamber, wherein the second reaction chamber is in fluid communication with the third transfer chamber via the second reaction chamber second gate valve in response to the second reaction chamber second gate valve being opened;

a third reaction chamber;

a third reaction chamber first gate valve coupled to the third reaction chamber and configured to allow transferring the substrate at least one of into or out of the third reaction chamber, wherein the third reaction chamber is in fluid communication with the third transfer chamber via the third reaction chamber first gate valve in response to the third reaction chamber first gate valve being opened;

a third reaction chamber second gate valve coupled to the third reaction chamber, wherein the third reaction chamber is in fluid communication with at least one of the first transfer chamber or the second transfer chamber via the third reaction chamber second gate valve in response to the third reaction chamber second gate valve being opened;

a first reactor system comprising the first reaction chamber, a first reactant source comprising a first reactant disposed therein, a first distribution system configured to distribute the first reactant to the first reaction chamber, and a first controller configured to supply the first reactant to the substrate in the first reaction chamber via the first distribution system for a first duration before transferring the substrate from the first reaction chamber;

a second reactor system comprising the second reaction chamber, a second reactant source comprising a second reactant disposed therein, a second distribution system configured to distribute the second reactant to the second reaction chamber, and a second controller

configured to supply the second reactant to the substrate in the second reaction chamber via the second distribution system for a second duration before transferring the substrate from the second reaction chamber; and

a third reactor system comprising the third reaction chamber, a third reactant source comprising a third reactant disposed therein, a third distribution system configured to distribute the third reactant to the third reaction chamber, and a third controller configured to supply the third reactant to the substrate in the third reaction chamber via the third distribution system for a third duration before transferring the substrate from the third reaction chamber,

wherein the first reactant is different from the second reactant and the third reactant, wherein the second reactant and the third reactant are the same, wherein the first duration is different from the second duration and the third duration, and wherein the second duration and the third duration are the same.

2. The reactor system of claim 1, wherein the first transfer chamber and the second transfer chamber are on opposite sides of the first reaction chamber.

3. The reactor system of claim 1, wherein the first transfer chamber and the second transfer chamber are disposed at an angle of less than 180 degrees with respect to an axis through the first reaction chamber.

4. The reactor system of claim 1, further comprising:

a fourth transfer chamber; and

a third reaction chamber third gate valve coupled to the third reaction chamber, wherein the third reaction chamber is in fluid communication with the fourth transfer chamber via the

third reaction chamber third gate valve in response to the third reaction chamber third gate valve being opened.

5. The reactor system of claim 1, further comprising:

a fourth transfer chamber; and

a third reaction chamber second gate valve coupled to the third reaction chamber, wherein the third reaction chamber is in fluid communication with the fourth transfer chamber via the third reaction chamber second gate valve in response to the third reaction chamber second gate valve being opened.

6. The reactor system of claim 5, further comprising a first reaction chamber third gate valve coupled to the first reaction chamber, wherein the fourth transfer chamber is in fluid communication with the first reaction chamber via the first reaction chamber third gate valve in response to the first reaction chamber third gate valve being opened.

7. The reactor system of claim 5, further comprising:

a fourth reaction chamber; and

a fourth reaction chamber first gate valve coupled to the fourth reaction chamber and configured to allow transferring the substrate at least one of into or out of the fourth reaction chamber,

wherein the fourth reaction chamber is in fluid communication with the fourth transfer chamber via the fourth reaction chamber first gate valve in response to the fourth reaction chamber first gate valve being opened.

8. The reactor system of claim 7, further comprising a fourth reaction chamber second gate valve coupled to the fourth reaction chamber, wherein the fourth reaction chamber is in fluid communication with the first transfer chamber via the fourth reaction chamber second gate valve in response to the fourth reaction chamber second gate valve being opened.

9. A reactor system, comprising:

a plurality of reaction chambers, wherein each of the plurality of reaction chambers comprises a local controller and a reactant source comprising a reactant disposed therein, wherein the local controller is configured to supply the reactant source for a set duration, wherein the set duration that the reactant source is supplied to a first respective reaction chamber of the plurality of reaction chambers is different from the set duration that the reactant source is supplied to a second respective reaction chamber and a third respective reaction chamber of the plurality of reaction chambers, wherein the set duration that the reactant source is supplied to the second respective reaction chamber of the plurality of reaction chambers is the same as the set duration that the reactant source is supplied to the third respective reaction chamber of the plurality of reaction chambers, wherein the reactant disposed in the reactant source of the first respective reaction chamber of the plurality of reaction chambers is different than the reactant disposed in the reactant source of the second respective reaction chamber and the third respective reaction chamber of the plurality of reaction chambers, wherein the reactant disposed in the reactant source of the second respective reaction chamber of the plurality of reaction chambers is the same as the reactant disposed in the reactant source of the third respective reaction chamber of the plurality of reaction chambers;

a plurality of transfer chambers; and

at least two gate valves coupled to each reaction chamber of the plurality of reaction chambers, wherein a first gate valve of the at least two gate valves fluidly couples the first

respective reaction chamber of the plurality of reaction chambers to a first transfer chamber of the plurality of transfer chambers when opened, and wherein a second gate valve of the at least two gate valves fluidly couples the first respective reaction chamber to a second transfer chamber of the plurality of transfer chambers when opened.

10. The reactor system of claim 9, wherein each of the plurality of transfer chambers comprises a transfer tool, wherein each transfer tool is configured to transfer a substrate at least one of into or out of a maximum of two of the plurality of reaction chambers.

11. A method, comprising:

transferring a first substrate to a first reaction chamber through a first reaction chamber first gate valve coupled to the first reaction chamber, via a first transfer tool comprised in a first transfer chamber, wherein the first reaction chamber and the first transfer chamber are in fluid communication in response to the first reaction chamber first gate valve being opened;

transferring the first substrate from the first reaction chamber through a first reaction chamber second gate valve coupled to the first reaction chamber, via a second transfer tool comprised in a second transfer chamber, wherein the second transfer chamber is in fluid communication with the first reaction chamber in response to the first reaction chamber second gate valve being opened;

transferring, via the second transfer tool, the substrate to a second reaction chamber through a second reaction chamber first gate valve coupled to the second reaction chamber, wherein the second reaction chamber is in fluid communication with the second transfer chamber in response to the second reaction chamber first gate valve being opened;

transferring the substrate from the second reaction chamber;

applying a first material to the substrate in the first reaction chamber for a first duration before the transferring the substrate from the first reaction chamber;

applying a second material to the substrate in the second reaction chamber for a second duration before the transferring the substrate from the second reaction chamber, wherein the transferring the substrate from the second reaction chamber is completed via a third transfer tool comprised in a third transfer chamber and through a second reaction chamber second gate valve coupled to the second reaction chamber, wherein the second reaction chamber and the third transfer chamber are in fluid communication in response to the second reaction chamber second gate valve being opened;

transferring, via the third transfer tool, the substrate to a third reaction chamber through a third reaction chamber first gate valve coupled to the third reaction chamber, wherein the third reaction chamber is in fluid communication with the third transfer chamber in response to the third reaction chamber first gate valve being opened; and

applying a third material to the substrate in the third reaction chamber for a third duration, wherein the second material and the third material are the same, wherein the first duration is different from the second duration and the third duration, and wherein the second duration and the third duration are the same.

12. The method of claim 11, wherein the transferring the substrate from the second reaction chamber is completed via the first transfer tool through a second reaction chamber second gate valve coupled to the second reaction chamber, wherein the second reaction chamber and the first transfer chamber are in fluid communication in response to the second reaction chamber second gate valve being opened.