[05a] Aspects of the invention are defined in the independent claims. Some optional features of the invention are defined in the dependent claims.

[06] Thus, in one exemplary arrangement, the present disclosure provides a reactor system that includes a housing and at least one reactor cell disposed within an interior of the housing. The at least one reactor cell comprising an enclosure and a plasmonic photocatalyst on a catalyst support disposed within the at least one enclosure, wherein the enclosure is optically transparent and comprises at least one input for a reactant to enter the at least one cell and at least one output for a reformate to exit the at least one cell;. When at least one light source is applied, the reactor cell is configured to transform the reactant into the reformate.

[07] In another exemplary arrangement, the present disclosure provides a solar concentrator and a photocatalytic reactor cell positioned relative to the solar concentrator to increase an incidence of electromagnetic radiation on the photocatalytic reactor cell.

[08] In yet another exemplary arrangement, the present disclosure provides a method for transforming at least one reactant into at least one reformate. The method includes (a) distributing at least one reactant into a plurality of reactor cells disposed within a housing, where each reactor cell comprises an optically transparent enclosure and a plasmonic photocatalyst on a catalyst support disposed within the optically transparent enclosure, (b) illuminating, via at least one light source, an interior of the housing to cause the plurality of reactor cells to transform at least one reactant into at least one reformate, and (c) accumulating the at least one reformate from the plurality of reactor cells.

BRIEF DESCRIPTION OF THE DRAWINGS

[09] The accompanying drawings are included to provide a further understanding of the methods and devices of the disclosure, and are incorporated in and constitute a part of this specification. The drawings are not necessarily to scale, and sizes of various elements may be distorted for clarity and/or illustrated as simplistic representations in order to promote comprehension. The drawings illustrate one or more embodiment(s) of the disclosure, and together with the description, serve to explain the principles and operation of the disclosure.

[010] **Figure 1A** is a cross-sectional side view of a reactor cell according to one embodiment of the disclosure.

[011] **Figure1B** is an exploded perspective side view of a reactor cell according to one embodiment of the disclosure.

[012] **Figure 2A** is a perspective side view of a configuration of a reactor system according to one embodiment of the disclosure.

[013] **Figure 2B** is an exploded perspective side view of a configuration of a reactor system according to the embodiment of Figure 2A.

[014] **Figures 3A** is cross-sectional side view of an example configuration of the reactor cell according to one embodiment of the disclosure.

What is claimed is:

1. A reactor system comprising:

a housing; and

a plurality of reactor cells arranged for disposal within an interior of the housing and arranged to surround at least one light source located in the housing, each of the plurality of reactor cells comprising:

an enclosure, the reactor system being configured for a plasmonic photocatalyst on a catalyst support to be disposed within the at least one enclosure, wherein the enclosure is optically transparent and comprises at least one input for a reactant to enter each of the plurality of reactor cells and at least one output for a reformate to exit each of the plurality of reactor cells;

wherein, upon application of the at least one light source, the plurality of reactor cells are configured to transform the reactant into the reformate.

2. The reactor system of claim 1, wherein the at least one light source is elongated and arranged coaxially along a central long axis of the housing.

3. The reactor system of claim 1, wherein the at least one light source is arranged coaxially with the plurality of reactor cells within the housing.

4. The reactor system of claim 1, wherein the at least one light source comprises at least one light source selected from the group consisting of an LED, a metal halide bulb, a high pressure sodium bulb, a xenon lamp, an incandescent bulb, a fluorescent bulb, a halogen bulb, a HID lamp, and a laser.

5. The reactor system of claim 1, wherein each of the plurality of reactor cells comprises an enclosure having an outer cavity and a central cavity arranged coaxially with the outer cavity, wherein the outer cavity of each reactor cell is arranged to contain the plasmonic photocatalyst on the catalyst support and the central cavity is configured to receive at least one of a light source or a thermal management feature.

6. The reactor system of claim 5, wherein the thermal management feature is at least one of a metal rod, metal wires, or a fluid thermal management system.

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

a reactor fluid distributor arranged for connection to the at least one input of each of the plurality of reactor cells; and

a fluid accumulator arranged for connection to the at least one output of each reactor cell.

8. The reactor system of claim 1, further comprising one or more fittings arranged for coupling each of the plurality of reactor cells to at least one delivery channel for delivering the at least one reactant to or the at least one reformate from the enclosure of each of the plurality of reactor cells.

9. The reactor system of claim 1, wherein the at least one reactant is in fluid form.

10. A reactor system for transforming one or more reactant gases comprising:

a housing; and

a plurality of fixed-bed reactor cells disposed within an interior of the housing to surround a light source disposed within the housing, each of the plurality of reactor cells comprising:

an optically transparent enclosure;

a first fitting configured to attach the reactor cell at a first end of the enclosure to at least one delivery channel for receiving at least one reactant input gas;

a second fitting configured to attach the reactor cell at a second end of the enclosure to at least one delivery channel for outputting at least one output gas; each of the plurality of reactor cells being configured for:

a catalyst support to be disposed as a fixed bed substantially filling an entirety of the enclosure; and

a first plasmonic photocatalyst to be supported by the catalyst support, wherein the first plasmonic photocatalyst comprises a catalyst coupled to a plasmonic material having a plasmon resonant frequency to catalyze a desired chemical reaction,

wherein, upon application of the light source to each of the plurality of reactor cells while the at least one reactant input gas is passed through the enclosure, each reactor cell is configured to transform the at least one reactant input gas into the at least one output gas via the at least one reactant input gas reacting with at least the first plasmonic photocatalyst.

11. A method for transforming at least one reactant gas, the method comprising:

distributing at least one reactant input gas into a plurality of fixed-bed reactor cells disposed within a housing, the plurality of reactor cells surrounding at least one light source, wherein each reactor cell comprises:

an optically transparent enclosure;

a catalyst support disposed as a fixed bed substantially filling an entirety of the enclosure; and

a plasmonic photocatalyst supported by the catalyst support, wherein the plasmonic photocatalyst comprises a catalyst coupled to a plasmonic material having a plasmon resonant frequency to catalyze a desired chemical reaction, the method further comprising:

illuminating, via the at least one light source, an interior of the housing while the at least one reactant input gas is distributed into the plurality of reactor cells to thereby cause the plurality of reactor cells to transform the at least one reactant input gas into at least one output gas via the at least one reactant input gas reacting with at least the plasmonic photocatalyst; and

accumulating the at least one output gas from the plurality of reactor cells.

12. The method of claim 11, wherein the housing comprises a reflective interior surface, and wherein the method further comprises reflecting light from the at least one light source off of the reflective interior surface of the housing and into the plurality of reactor cells.

13. The method of claim 11, wherein the optically transparent enclosure of each of the plurality of reactor cells comprises an outer cavity and a central cavity arranged coaxially with the outer cavity, wherein the outer cavity of each reactor cell contains at least the first plasmonic photocatalyst on the catalyst support and the central cavity of each reactor cell contains a light source, and wherein the illuminating is at least partially from the light source contained in the central cavity of each of the plurality of reactor cells.

14. The method of claim 11, wherein the optically transparent enclosure of each of the plurality of reactor cells comprises an outer cavity and a central cavity arranged coaxially with the outer cavity, wherein the outer cavity of each reactor cell contains at least the first plasmonic photocatalyst on the catalyst support and the central cavity of each reactor cell contains a thermal management feature, and wherein the method further comprises heating, via the thermal management feature in each of the plurality of reactor cells, the plurality of reactor cells to assist in transforming the at least one reactant input gas.

15. The method of claim 14, wherein heating, via the thermal management feature in each of the plurality of reactor cells, comprises supplying fluid from a fluid input coupled to a first end of the central cavity of each of the plurality of reactor cells to a fluid output coupled to a second end of the central cavity of each of the plurality of reactor cells, such that the fluid heats each of the plurality of reactor cells.

16. The method of claim 11, further comprising heating the plurality of reactor cells via the at least one reactant input gas reacting with at least the first plasmonic photocatalyst in each of the plurality of reactor cells.

17. The method of claim 11, wherein the at least one light source includes a light source external to the housing, wherein the housing is at least partially optically transparent, and wherein illuminating the interior of the housing includes directing electromagnetic radiation from the light source through the housing and into the plurality of photocatalytic reactor cells.

18. A reactor system comprising:

a housing;

a plurality of reactor cells disposed within the housing, each reactor cell comprising:

an enclosure having a reflective interior surface;

an input,

an output, and

a light source; and

at least one plasmonic photocatalyst on a catalyst support disposed within the enclosure, wherein the plasmonic photocatalyst comprises a catalyst coupled to a plasmonic material;

a distributor for distributing at least one reactant into the plurality of reactor cells via the input of each reactor cell; and

an accumulator for accumulating at least one reformate from the plurality of reactor cells via the output of each reactor cell.

19. The reactor system of claim 1, wherein the optically transparent enclosure of each of the plurality of reactor cells has at least 50% transmittance for at least one predetermined light wavelength.

20. The reactor system of claim 1, wherein the optically transparent enclosure of each of the plurality of reactor cells comprises glass, borosilicate glass, quartz, fused quartz, aluminosilicate glass, lithium-aluminosilicate glass, sapphire, or combinations thereof.

21. The reactor system of claim 1, wherein the catalyst support of each of the plurality of reactor cells is selected to have an absorbance sufficiently low to catalyze the transformation of the at least one reactant input gas into the at least one output gas for at least one predetermined light wavelength.

22. The reactor system of claim 1, wherein the catalyst support of each of the plurality of reactor cells comprises silica, quartz, fused quartz, glass, borosilicate glass, sapphire, diamond, or combination thereof.

23. The reactor system of claim 1, wherein the catalyst support of each of the plurality of reactor cells is an aerogel comprising silicon dioxide, aluminum oxide, titanium dioxide, zirconium dioxide, holmium oxide, samarium oxide, erbium oxide, neodymium(III) oxide, or a combination thereof.

24. The reactor system of claim 5, wherein the thermal management feature includes (a) a fluid input coupled to a first end of the central cavity of each reactor cell and (b) a fluid output coupled to a second end of the central cavity of each reactor cell, such that a supplied fluid may flow through each of the plurality of reactor cells to modify a temperature of the reactor system.

25. The reactor system of claim 5, wherein the thermal management feature comprises at least one metal rod or a plurality of metal wires.

26. The reactor system of claim 1, wherein the photocatalyst is a first photocatalyst, wherein each of the plurality of reactor cells further comprises a second plasmonic photocatalyst supported by the catalyst support, and wherein the second plasmonic photocatalyst differs from the first plasmonic photocatalyst.

27. The reactor system of claim 26, wherein the second plasmonic photocatalyst has a different plasmon resonant frequency from that of the first plasmonic photocatalyst.

28. The reactor system of claim 26, wherein the second plasmonic photocatalyst has a different diameter from that of the first plasmonic photocatalyst.

29. The reactor system of claim 26, wherein the first plasmonic photocatalyst and second plasmonic photocatalyst are arranged in different layers from one another.

30. The reactor system of claim 26, wherein the first plasmonic photocatalyst absorbs a first wavelength range relative to other wavelengths, while the second plasmonic photocatalyst absorbs a second wavelength range relative to other wavelengths, and wherein the first wavelength range differs from the second wavelength range.