Claims

1. A reactor system comprising:

a housing; and

a plurality of reactor cells within an interior of the housing and arranged surrounding at least one light source, the at least one light source arranged coaxially in the housing,

each of the plurality of reactor cells comprising:

an optically transparent enclosure,

a catalyst support disposed within the enclosure,

a plasmonic photocatalyst on 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,

at least one input receiving a reactant to enter each of the plurality of reactor cells, and

at least one output of a reformate exiting each of the plurality of reactor cells;

wherein, the at least one light source is applied to the plurality of enclosures, the plurality of reactor cells transforming 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 comprises 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 connected to the at least one input of each of the plurality of reactor cells; and

a fluid accumulator connected to the at least one output of each reactor cell.

8. The reactor system of claim 1, further comprising one or more fittings coupling each of the plurality of reactor cells to at least one delivery channel and 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 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, the light source arranged coaxially in the housing, each of the plurality of reactor cells comprising:

an optically transparent enclosure;

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

a second fitting attached the reactor cell at a second end of the enclosure to at least one delivery channel and outputting at least one output gas;

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

a first plasmonic photocatalyst 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, the light source is applied to each of the plurality of reactor cells while the at least one reactant input gas is passed through the enclosure, each reactor cell transforms 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 arranged coaxially in the housing,

supporting a plasmonic photocatalyst on a fixed bed substantially filling an entirety of an optically transparent enclosure within each of the plurality of reactor cells, wherein the plasmonic photocatalyst comprises a catalyst coupled to a plasmonic material having a plasmon resonant frequency to catalyze a desired chemical reaction,

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;

transforming 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, further comprising reflecting light from the at least one light source off of a 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 having a plasmon resonant frequency to catalyze a desired chemical reaction;

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 has 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, and a supplied fluid flows through each of the plurality of reactor cells and modifies 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 plasmonic 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.

31. A reactor system comprising:

a housing; and

a plurality of reactor cells arranged surrounding at least one light source, the least one light source arranged coaxially in the housing, each of the plurality of reactor cells comprising:

an optically transparent enclosure,

a catalyst support configured to be within the enclosure,

a plasmonic photocatalyst configured to be on 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,

at least one input configured for a reactant to enter each of the plurality of reactor cells, and

at least one output configured for a reformate to exit each of the plurality of reactor cells;

wherein, the at least one light source is configured to illuminate the plurality of enclosures, and the plurality of reactor cells are configured to transform the reactant into the reformate.

32. The reactor system of claim 31, 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 configured 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.

33. The reactor system of claim 31, wherein the photocatalyst is a first plasmonic 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.

34. The reactor system of claim 33, wherein the first plasmonic photocatalyst and second plasmonic photocatalyst are arranged in different layers from one another.

35. The reactor system of claim 33, 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.

33. A reactor system configured to transform one or more reactant gases comprising:

a housing; and

a plurality of fixed-bed reactor cells disposed within an interior of the housing surrounding a light source disposed within and arranged coaxially in the housing, each of the plurality of reactor cells comprising:

an optically transparent enclosure;

a first end of the enclosure for receiving at least one reactant input gas;

a a second end of the enclosure configured for outputting at least one output gas;

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

a first plasmonic photocatalyst configured 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, the light source is configured to illuminate 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.