ELECTRICAL POWER GENERATION SYSTEMS AND METHODS REGARDING SAME

CROSS-REFERENCES OF RELATED APPLICATIONS

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The present disclosure relates to the field of power generation and, in particular, to systems, devices, and methods for the generation of power. More specifically, embodiments of the present disclosure are directed to power generation devices and systems, as well as related methods, which produce optical power, plasma, and thermal power and produces electrical power via an optical to electric power converter, plasma to electric power converter, photon to electric power converter, or a thermal to electric power converter. In addition, embodiments of the present disclosure describe systems, devices, and methods that use the ignition of a water or water-based fuel source to generate optical power, mechanical power, electrical power, and/or thermal power using photovoltaic power converters. These and other related embodiments are described in detail in the present disclosure.

Power generation can take many forms, harnessing the power from plasma. Successful commercialization of plasma may depend on power generation systems capable of efficiently forming plasma and then capturing the power of the plasma produced.

Plasma may be formed during ignition of certain fuels. These fuels can include water or water-based fuel source. During ignition, a plasma cloud of electron-stripped atoms is formed, and high optical power may be released. The high optical power of the plasma can be harnessed by an electric converter of the present disclosure. The ions and excited state atoms can recombine and undergo electronic relaxation to emit optical power. The optical power can be converted to electricity with photovoltaics.

Summary

In an aspect, the present disclosure refers to a method comprising:

a) producing a voltage differential between a set of electrodes separated to form an open circuit;

b) injecting a conductive material and H2O between said electrodes to close said open circuit and form a current and voltage across said conductive material;

wherein said conductive material comprises metal and a metal oxide, and wherein the current and voltage in said closed circuit and conductive material is capable of initiating a plasma forming reaction when H2O is present as nascent molecules;

c) collecting the products of said plasma forming reaction;

d) regenerating said conductive material from said collected products; and

e) loading said regenerated conductive material between said electrodes.

In an aspect, the present disclosure refers to a method comprising:

a) producing a voltage differential between a set of electrodes separated to form an open circuit;

b) injecting a conductive material and H2O between said electrodes to close said open circuit and form a current and voltage across said conductive material;

wherein said conductive material comprises metal and a metal halide; and wherein the current and voltage in said closed circuit and conductive material is capable of initiating a plasma forming reaction when H2O is present as nascent molecules;

c) collecting the products of said plasma forming reaction;

d) regenerating said conductive material from said collected products; and

e) loading said regenerated conductive material between said electrodes.

Certain examples of the present disclosure are directed to a power generation system comprising: a plurality of electrodes configured to deliver power to a fuel to ignite the fuel and produce a plasma; a source of electrical power configured to deliver electrical energy to the plurality of electrodes; and at least one photovoltaic power converter positioned to receive at least a plurality of plasma photons.

In one example, the present disclosure is directed to a power system that generates at least one of electrical energy and thermal energy comprising:

at least one vessel capable of a pressure of below atmospheric;

shot comprising reactants, the reactants comprising:

a) at least one source of catalyst or a catalyst comprising nascent H_2O;

b) at least one source of H_2O or H_2O;

c) at least one source of atomic hydrogen or atomic hydrogen; and

d) at least one of a conductor and a conductive matrix;

at least one shot injection system comprising at least one augmented railgun, wherein the augmented railgun comprises separated electrified rails and magnets that produce a magnetic field perpendicular to the plane of the rails, and the circuit between the rails is open until closed by the contact of the shot with the rails;

at least one ignition system to cause the shot to form at least one of light-emitting plasma and thermal-emitting plasma, at least one ignition system comprising:

a) at least one set of electrodes to confine the shot; and

b) a source of electrical power to deliver a short burst of high-current electrical energy;

wherein the at least one set of electrodes form an open circuit, wherein the open circuit is closed by the injection of the shot to cause the high current to flow to achieve ignition, and the source of electrical power to deliver a short burst of high-current electrical energy comprises at least one of the following:

a voltage selected to cause a high AC, DC, or an AC-DC mixture of current that is in the range of at least one of 100 A to 1,000,000 A, 1 kA to 100,000 A, 10 kA to 50 kA;

a DC or peak AC current density in the range of at least one of 100 A/cm^2 to 1,000,000 A/cm^2, 1000 A/cm^2 to 100,000 A/cm^2, and 2000 A/cm^2 to 50,000 A/cm^2;

the voltage is determined by the conductivity of the solid fuel or energetic material wherein the voltage is given by the desired current times the resistance of the solid fuel or energetic material sample;

the DC or peak AC voltage is in the range of at least one of 0.1 V to 500 kV, 0.1 V to 100 kV, and 1 V to 50 kV, and

the AC frequency is in range of at least one of 0.1 Hz to 10 GHz, 1 Hz to 1 MHz, 10 Hz to 100 kHz, and 100 Hz to 10 kHz.

a system to recover reaction products of the reactants comprising at least one of gravity and an augmented plasma railgun recovery system comprising at least one magnet providing a magnetic field and a vector-crossed current component of the ignition electrodes;

at least one regeneration system to regenerate additional reactants from the reaction products and form additional shot comprising a pelletizer comprising a smelter to form molten reactants, a system to add H_2 and H_2O to the molten reactants, a melt dripper, and a water reservoir to form shot,

wherein the additional reactants comprise:

a) at least one source of catalyst or a catalyst comprising nascent H_2O;

b) at least one source of H_2O or H_2O;

c) at least one source of atomic hydrogen or atomic hydrogen; and

d) at least one of a conductor and a conductive matrix; and

at least one power converter or output system of at least one of the light and thermal output to electrical power and/or thermal power comprising at least one or more of the group of a photovoltaic converter, a photoelectronic converter, a plasmadynamic converter, a thermionic converter, a thermoelectric converter, a Sterling engine, a Brayton cycle engine, a Rankine cycle engine, and a heat engine, and a heater.

In another example, the present disclosure is directed to a power system that generates at least one of electrical energy and thermal energy comprising:

at least one vessel capable of a pressure of below atmospheric;

shot comprising reactants, the reactants comprising at least one of silver, copper, absorbed hydrogen, and water;

at least one shot injection system comprising at least one augmented railgun wherein the augmented railgun comprises separated electrified rails and magnets that produce a magnetic field perpendicular to the plane of the rails, and the circuit between the rails is open until closed by the contact of the shot with the rails;

at least one ignition system to cause the shot to form at least one of light-emitting plasma and thermal-emitting plasma, at least one ignition system comprising:

a) at least one set of electrodes to confine the shot; and

b) a source of electrical power to deliver a short burst of high-current electrical energy;

wherein the at least one set of electrodes that are separated to form an open circuit, wherein the open circuit is closed by the injection of the shot to cause the high current to flow to achieve ignition, and he source of electrical power to deliver a short burst of high-current electrical energy comprises at least one of the following:

a voltage selected to cause a high AC, DC, or an AC-DC mixture of current that is in the range of at least one of 100 A to 1,000,000 A, 1 kA to 100,000 A, 10 kA to 50 kA;

a DC or peak AC current density in the range of at least one of 100 A/cm^2 to 1,000,000 A/cm^2, 1000 A/cm^2 to 100,000 A/cm^2, and 2000 A/cm^2 to 50,000 A/cm^2;

the voltage is determined by the conductivity of the solid fuel or energetic material wherein the voltage is given by the desired current times the resistance of the solid fuel or energetic material sample;

the DC or peak AC voltage is in the range of at least one of 0.1 V to 500 kV, 0.1 V to 100 kV, and 1 V to 50 kV, and

the AC frequency is in range of at least one of 0.1 Hz to 10 GHz, 1 Hz to 1 MHz, 10 Hz to 100 kHz, and 100 Hz to 10 kHz.

a system to recover reaction products of the reactants comprising at least one of gravity and a augmented plasma railgun recovery system comprising at least one magnet providing a magnetic field and a vector-crossed current component of the ignition electrodes;

at least one regeneration system to regenerate additional reactants from the reaction products and form additional shot comprising a pelletizer comprising a smelter to form molten reactants, a system to add H_2 and H_2O to the molten reactants, a melt dripper, and a water reservoir to form shot,

wherein the additional reactants comprise at least one of silver, copper, absorbed hydrogen, and water;

at least one power converter or output system comprising a concentrator ultraviolet photovoltaic converter wherein the photovoltaic cells comprise at least one compound chosen from a Group III nitride, GaAlN, GaN, and InGaN.

In another example, the present disclosure is directed to a power system that generates at least one of electrical energy and thermal energy comprising:

at least one vessel;

shot comprising reactants, the reactants comprising:

e) at least one source of catalyst or a catalyst comprising nascent H_2O;

f) at least one source of H_2O or H_2O;

g) at least one source of atomic hydrogen or atomic hydrogen; and

h) at least one of a conductor and a conductive matrix;

at least one shot injection system;

at least one shot ignition system to cause the shot to form at least one of light-emitting plasma and thermal-emitting plasma;

a system to recover reaction products of the reactants;

at least one regeneration system to regenerate additional reactants from the reaction products and form additional shot,

wherein the additional reactants comprise:

e) at least one source of catalyst or a catalyst comprising nascent H_2O;

f) at least one source of H_2O or H_2O;

g) at least one source of atomic hydrogen or atomic hydrogen; and

h) at least one of a conductor and a conductive matrix; and

at least one power converter or output system of at least one of the light and thermal output to electrical power and/or thermal power.

In another example, the present disclosure is directed to a power system that generates at least one of electrical energy and thermal energy comprising:

at least one vessel;

slurry comprising reactants, the reactants comprising:

a) at least one source of catalyst or a catalyst comprising nascent H_2O;

b) at least one source of H_2O or H_2O;

c) at least one source of atomic hydrogen or atomic hydrogen; and

d) at least one of a conductor and a conductive matrix;

at least one slurry injection system comprising rotating roller electrodes comprising a rotary slurry pump;

at least one slurry ignition system to cause the shot to form light-emitting plasma;

a system to recover reaction products of the reactants;

at least one regeneration system to regenerate additional reactants from the reaction products and form additional slurry,

wherein the additional reactants comprise:

a) at least one source of catalyst or a catalyst comprising nascent H_2O;

b) at least one source of H_2O or H_2O;

c) at least one source of atomic hydrogen or atomic hydrogen; and

d) at least one of a conductor and a conductive matrix; and

at least one power converter or output system of at least one of the light and thermal output to electrical power and/or thermal power.

Certain examples of the present disclosure are directed to a power generation system comprising: a plurality of electrodes configured to deliver power to a fuel to ignite the fuel and produce a plasma; a source of electrical power configured to deliver electrical energy to the plurality of electrodes; and at least one photovoltaic power converter positioned to receive at least a plurality of plasma photons.

In one example, the present disclosure is directed to a power system that generates at least one of direct electrical energy and thermal energy comprising:

at least one vessel;

reactants comprising:

a) at least one source of catalyst or a catalyst comprising nascent H_2O;

b) at least one source of atomic hydrogen or atomic hydrogen;

c) at least one of a conductor and a conductive matrix; and

at least one set of electrodes to confine the hydrino reactants,

a source of electrical power to deliver a short burst of high-current electrical energy;

a reloading system;

at least one system to regenerate the initial reactants from the reaction products, and

at least one plasma dynamic converter or at least one photovoltaic converter.

In one exemplary example, a method of producing electrical power may comprise supplying a fuel to a region between a plurality of electrodes; energizing the plurality of electrodes to ignite the fuel to form a plasma; converting a plurality of plasma photons into electrical power with a photovoltaic power converter; and outputting at least a portion of the electrical power.

In another exemplary example, a method of producing electrical power may comprise supplying a fuel to a region between a plurality of electrodes; energizing the plurality of electrodes to ignite the fuel to form a plasma; converting a plurality of plasma photons into thermal power with a photovoltaic power converter; and outputting at least a portion of the electrical power.

In an example of the present disclosure, a method of generating power may comprise delivering an amount of fuel to a fuel loading region, wherein the fuel loading region is located among a plurality of electrodes; igniting the fuel by flowing a current of at least about 2,000 A/cm^2 through the fuel by applying the current to the plurality of electrodes to produce at least one of plasma, light, and heat; receiving at least a portion of the light in a photovoltaic power converter; converting the light to a different form of power using the photovoltaic power converter; and outputting the different form of power.

In an additional example, the present disclosure is directed to a water arc plasma power system comprising: at least one closed reaction vessel; reactants comprising at least one of source of H_2O and H_2O; at least one set of electrodes; a source of electrical power to deliver an initial high breakdown voltage of the H_2O and provide a subsequent high current, and a heat exchanger system, wherein the power system generates arc plasma, light, and thermal energy, and at least one photovoltaic power converter.

Certain examples of the present disclosure are directed to a power generation system comprising: an electrical power source of at least about 2,000 A/cm^2 or of at least about 5,000

kW; a plurality of electrodes electrically coupled to the electrical power source; a fuel loading region configured to receive a solid fuel, wherein the plurality of electrodes is configured to deliver electrical power to the solid fuel to produce a plasma; and at least one of a plasma power converter, a photovoltaic power converter, and thermal to electric power converter positioned to receive at least a portion of the plasma, photons, and/or heat generated by the reaction. Other examples are directed to a power generation system, comprising: a plurality of electrodes; a fuel loading region located between the plurality of electrodes and configured to receive a conductive fuel, wherein the plurality of electrodes are configured to apply a current to the conductive fuel sufficient to ignite the conductive fuel and generate at least one of plasma and thermal power; a delivery mechanism for moving the conductive fuel into the fuel loading region; and at least one of a photovoltaic power converter to convert the plasma photons into a form of power, or a thermal to electric converter to convert the thermal power into a nonthermal form of power comprising electricity or mechanical power. Further examples are directed to a method of generating power, comprising: delivering an amount of fuel to a fuel loading region, wherein the fuel loading region is located among a plurality of electrodes; igniting the fuel by flowing a current of at least about 2,000 A/cm^2 through the fuel by applying the current to the plurality of electrodes to produce at least one of plasma, light, and heat; receiving at least a portion of the light in a photovoltaic power converter; converting the light to a different form of power using the photovoltaic power converter; and outputting the different form of power.

Additional examples are directed to a power generation system, comprising: an electrical power source of at least about 5,000 kW; a plurality of spaced apart electrodes, wherein the plurality of electrodes at least partially surround a fuel, are electrically connected to the electrical power source, are configured to receive a current to ignite the fuel, and at least one of the plurality of electrodes is moveable; a delivery mechanism for moving the fuel; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power. Additionally provided in the present disclosure is a power generation system, comprising: an electrical power source of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes, wherein the plurality of electrodes at least partially surround a fuel, are electrically connected to the electrical power source, are configured to receive a current to ignite the fuel, and at least one of the plurality of electrodes is moveable; a delivery mechanism for moving the fuel; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power.

Another example is directed to a power generation system, comprising: an electrical power source of at least about 5,000 kW or of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes, wherein at least one of the plurality of electrodes includes a compression

mechanism; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes so that the compression mechanism of the at least one electrode is oriented towards the fuel loading region, and wherein the plurality of electrodes are electrically connected to the electrical power source and configured to supply power to the fuel received in the fuel loading region to ignite the fuel; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert photons generated from the ignition of the fuel into a non-photon form of power. Other examples of the present disclosure are directed to a power generation system, comprising: an electrical power source of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes, wherein at least one of the plurality of electrodes includes a compression mechanism; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes so that the compression mechanism of the at least one electrode is oriented towards the fuel loading region, and wherein the plurality of electrodes are electrically connected to the electrical power source and configured to supply power to the fuel received in the fuel loading region to ignite the fuel; a delivery mechanism for moving the fuel into the fuel loading region; and a plasma power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power.

Examples of the present disclosure are also directed to power generation system, comprising: a plurality of electrodes; a fuel loading region surrounded by the plurality of electrodes and configured to receive a fuel, wherein the plurality of electrodes is configured to ignite the fuel located in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; a photovoltaic power converter configured to convert photons generated from the ignition of the fuel into a non-photon form of power; a removal system for removing a byproduct of the ignited fuel; and a regeneration system operably coupled to the removal system for recycling the removed byproduct of the ignited fuel into recycled fuel. Certain examples of the present disclosure are also directed to a power generation system, comprising: an electrical power source configured to output a current of at least about 2,000 A/cm^2 or of at least about 5,000 kW; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert a plurality of photons generated from the ignition of the fuel into a non-photon form of power. Certain examples may further include one or more of output power terminals operably coupled to the photovoltaic power converter; a power storage device; a sensor

configured to measure at least one parameter associated with the power generation system; and a controller configured to control at least a process associated with the power generation system. Certain examples of the present disclosure are also directed to a power generation system, comprising: an electrical power source configured to output a current of at least about 2,000 A/cm^2 or of at least about 5,000 kW; a plurality of spaced apart electrodes, wherein the plurality of electrodes at least partially surround a fuel, are electrically connected to the electrical power source, are configured to receive a current to ignite the fuel, and at least one of the plurality of electrodes is moveable; a delivery mechanism for moving the fuel; and a photovoltaic power converter configured to convert photons generated from the ignition of the fuel into a different form of power.

Additional examples of the present disclosure are directed to a power generation system, comprising: an electrical power source of at least about 5,000 kW or of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; a photovoltaic power converter configured to convert a plurality of photons generated from the ignition of the fuel into a non-photon form of power; a sensor configured to measure at least one parameter associated with the power generation system; and a controller configured to control at least a process associated with the power generation system. Further examples are directed to a power generation system, comprising: an electrical power source of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; a plasma power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power; a sensor configured to measure at least one parameter associated with the power generation system; and a controller configured to control at least a process associated with the power generation system.

Certain examples of the present disclosure are directed to a power generation system, comprising: an electrical power source of at least about 5,000 kW or of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to

supply power to the fuel to ignite the fuel when received in the fuel loading region, and wherein a pressure in the fuel loading region is a partial vacuum; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power. Some examples may include one or more of the following additional features: the photovoltaic power converter may be located within a vacuum cell; the photovoltaic power converter may include at least one of an antireflection coating, an optical impedance matching coating, or a protective coating; the photovoltaic power converter may be operably coupled to a cleaning system configured to clean at least a portion of the photovoltaic power converter; the power generation system may include an optical filter; the photovoltaic power converter may comprise at least one of a monocrystalline cell, a polycrystalline cell, an amorphous cell, a string/ribbon silicon cell, a multi-junction cell, a homojunction cell, a heterojunction cell, a p-i-n device, a thin-film cell, a dye-sensitized cell, and an organic photovoltaic cell; and the photovoltaic power converter may comprise at multi-junction cell, wherein the multi-junction cell comprises at least one of an inverted cell, an upright cell, a lattice-mismatched cell, a lattice-matched cell, and a cell comprising Group III-V semiconductor materials.

Additional exemplary examples are directed to a system configured to produce power, comprising: a fuel supply configured to supply a fuel; a power supply configured to supply an electrical power; and at least one gear configured to receive the fuel and the electrical power, wherein the at least one gear selectively directs the electrical power to a local region about the gear to ignite the fuel within the local region. In some examples, the system may further have one or more of the following features: the fuel may include a powder; the at least one gear may include two gears; the at least one gear may include a first material and a second material having a lower conductivity than the first material, the first material being electrically coupled to the local region; and the local region may be adjacent to at least one of a tooth and a gap of the at least one gear. Other examples may use a support member in place of a gear, while other examples may use a gear and a support member. Some examples are directed to a method of producing electrical power, comprising: supplying a fuel to rollers or a gear; rotating the rollers or gear to localize at least some of the fuel at a region of the rollers or gear; supplying a current to the roller or gear to ignite the localized fuel to produce energy; and converting at least some of the energy produced by the ignition into electrical power. In some examples, rotating the rollers or gear may include rotating a first roller or gear and a roller or second gear, and supplying a current may include supplying a current to the first roller or gear and the roller or second gear.

Other examples are directed to a power generation system, comprising: an electrical

power source of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region, and wherein a pressure in the fuel loading region is a partial vacuum; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power.

Further examples are directed to a power generation cell, comprising: an outlet port coupled to a vacuum pump; a plurality of electrodes electrically coupled to an electrical power source of at least about 5,000 kW; a fuel loading region configured to receive a water-based fuel comprising a majority H_2O, wherein the plurality of electrodes is configured to deliver power to the water-based fuel to produce at least one of an arc plasma and thermal power; and a power converter configured to convert at least a portion of at least one of the arc plasma and the thermal power into electrical power. Also disclosed is a power generation system, comprising: an electrical power source of at least about 5,000 A/cm^2; a plurality of electrodes electrically coupled to the electrical power source; a fuel loading region configured to receive a water-based fuel comprising a majority H_2O, wherein the plurality of electrodes is configured to deliver power to the water-based fuel to produce at least one of an arc plasma and thermal power; and a power converter configured to convert at least a portion of at least one of the arc plasma and the thermal power into electrical power. In an example, the power converter comprises a photovoltaic converter of optical power into electricity.

Additional examples are directed to a method of generating power, comprising: loading a fuel into a fuel loading region, wherein the fuel loading region includes a plurality of electrodes; applying a current of at least about 2,000 A/cm^2 to the plurality of electrodes to ignite the fuel to produce at least one of an arc plasma and thermal power; performing at least one of passing the arc plasma through a photovoltaic converter to generate electrical power; and passing the thermal power through a thermal-to-electric converter to generate electrical power; and outputting at least a portion of the generated electrical power. Also disclosed is a power generation system, comprising: an electrical power source of at least about 5,000 kW; a plurality of electrodes electrically coupled to the power source, wherein the plurality of electrodes is configured to deliver electrical power to a water-based fuel comprising a majority H_2O to produce a thermal power; and a heat exchanger configured to convert at least a portion of the thermal power into electrical power; and a photovoltaic power converter configured to convert at least a portion of the light into electrical power. In addition, another example is directed to a