SUMMARY

In an aspect, the present disclosure refers to a power generation system comprising:

a.) at least one vessel capable of a maintaining a pressure below atmospheric comprising a reaction chamber;

b) two electrodes configured to allow a molten metal flow therebetween to complete a circuit;

c) a power source connected to said two electrodes to apply a current therebetween when said circuit is closed;

d) a plasma generation cell (e.g., glow discharge cell) to induce the formation of a first plasma from a gas; wherein effluence of the plasma generation cell is directed towards the circuit (e.g., the molten metal, the anode, the cathode, an electrode submerged in a molten metal reservoir);

wherein when current is applied across the circuit, the effluence of the plasma generation cell undergoes a reaction to producing a second plasma and reaction products; and

e) a power adapter configured to convert and/or transfer energy from the second plasma into mechanical, thermal, and/or electrical energy.

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

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

reactants capable of undergoing a reaction that produces enough energy to form a plasma in the vessel comprising:

a) a mixture of hydrogen gas and oxygen gas, and/or

water vapor, and/or

a mixture of hydrogen gas and water vapor;

b) a molten metal;

a mass flow controller to control the flow rate of at least one reactant into the vessel;

a vacuum pump to maintain the pressure in the vessel below atmospheric pressure when one or more reactants are flowing into the vessel;

a molten metal injector system comprising at least one reservoir that contains some of the molten metal, a molten metal pump system (e.g., one or more electromagnetic pumps) configured to deliver the molten metal in the reservoir and through an injector tube to provide a molten metal stream, and at least one non-injector molten metal reservoir for receiving the molten metal stream;

at least one ignition system comprising a source of electrical power or ignition current to supply electrical power to the at least one stream of molten metal to ignite the reaction when the hydrogen gas and/or oxygen gas and/or water vapor are flowing into the vessel;

a reactant supply system to replenish reactants that are consumed in the reaction;

a power converter or output system to convert a portion of the energy produced from the reaction (e.g., light, plasma jet, and/or thermal output from the plasma) to electrical power and/or thermal power.

In another aspect, the present disclosure refers to a power system comprising

a.) a vessel capable of a maintaining a pressure below atmospheric comprising a reaction chamber;

b) a plurality of electrode pairs, each pair comprising electrodes configured to allow a molten metal flow therebetween to complete a circuit.

c) a power source connected to said two electrodes to apply a current therebetween when said circuit is closed;

d) a plasma generation cell (e.g., glow discharge cell) to induce the formation of a first plasma from a gas; wherein effluence of the plasma generation cell is directed towards the circuit (e.g., the molten metal, the anode, the cathode, an electrode submerged in a molten metal reservoir);

wherein when current is applied across the circuit, the effluence of the plasma generation cell undergoes a reaction to producing a second plasma and reaction products; and

e) a power adapter configured to convert and/or transfer energy from the second plasma into mechanical, thermal, and/or electrical energy;

wherein at least one of the reaction products (*e.g.*, intermediates, final products) has at least one spectroscopic signature as described herein (*e.g.*, as shown in Example 10).

In another aspect, the present disclosure refers to an electrode system comprising:

a) a first electrode and a second electrode;

b) a stream of molten metal (*e.g.*, molten silver, molten gallium) in electrical contact with said first and second electrodes;

c) a circulation system comprising a pump to draw said molten metal from a reservoir and convey it through a conduit (*e.g.*, a tube) to produce said stream of molten metal exiting said conduit;

d) a source of electrical power configured to provide an electrical potential difference between said first and second electrodes;

wherein said stream of molten metal is in simultaneous contact with said first and second electrodes to create an electrical current between said electrodes.

In another aspect, the present disclosure refers to an electrical circuit comprising:

a) a heating means for producing molten metal;

b) a pumping means for conveying said molten metal from a reservoir through a conduit to produce a stream of said molten metal exiting said conduit;

c) a first electrode and a second electrode in electrical communication with a power supply means for creating an electrical potential difference across said first and second electrode;

wherein said stream of molten metal is in simultaneous contact with said first and second electrodes to create an electrical circuit between said first and second electrodes.

In another aspect, the present disclosure refers to: in an electrical circuit comprising a first and second electrode, the improvement comprising passing a stream of molten metal across said electrodes to permit a current to flow there between.

In another aspect, the present disclosure refers to a system for producing a plasma comprising:

a) a molten metal injector system configured to produce a stream of molten metal from a metal reservoir;

b) an electrode system for inducing a current to flow through said stream of molten metal;

c) at least one of a (i) water injection system configured to bring a metered volume of water in contact with molten metal, wherein a portion of said water and a portion of said molten metal react to form an oxide of said metal and hydrogen gas, (ii) a mixture of excess hydrogen gas an oxygen gas, and (iii) a mixture of excess hydrogen gas and water vapor, and

d) a power supply configured to supply said current;

wherein said plasma is produced when current is supplied through said metal stream.

In another aspect, the present disclosure refers to a system for generating a plasma comprising:

a) two electrodes configured to allow a molten metal flow therebetween to complete a circuit;

b) a power source connected to said two electrodes to apply a current therebetween when said circuit is closed;

c) a recombiner cell (*e.g.*, glow discharge cell) to induce the formation of nascent water and atomic hydrogen from a gas; wherein effluence of the recombiner is directed towards the circuit (*e.g.*, the molten metal, the anode, the cathode, an electrode submerged in a molten metal reservoir);

wherein when current is applied across the circuit, the effluence of the recombiner cell undergoes a reaction to produce a plasma.

In another aspect, the present disclosure refers to a superconducting quantum interference device (SQUID) or SQUID-type electronic element comprising at least one hydrino species $H^-\left(1/p\right)$ and $H_2\left(1/p\right)$ (or species having spectroscopic features that match these species) and at least one of an input current and input voltage circuit and an output current and output voltage circuit to at least one of sense and change the flux linkage state of at least one of the hydrino hydride ion and molecular hydrino.

In another aspect, the present disclosure refers to a superconducting quantum interference device (SQUID) comprising: at least two Josephson junctions electrically connected to a superconducting loop,

wherein the Josephson Junction comprising a hydrogen species H_2 that is EPR active.

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

a) electrically biasing a molten metal;

b) directing the effluence of a plasma generation cell (*e.g.*, a glow discharge cell) to interact with the biased molten metal and induce the formation of a plasma.

In another aspect, the present disclosure refers to a cryogen, a gaseous heat transfer agent, and an agent for buoyancy comprising molecular hydrino (*e.g.*, species having spectroscopic features that match molecular hydrino).

In another aspect, the present disclosure refers to an MRI gas contrast agent comprising molecular hydrino (*e.g.*, species having spectroscopic features that match molecular hydrino).

In another aspect, the present disclosure refers to a hydrino molecular gas laser comprising molecular hydrino gas ($H_2(1/p)$ p =2,3,4,5,…,137) (*e.g.*, species having spectroscopic features that match molecular hydrino), a laser cavity containing the molecular hydrino gas, a source of excitation of rotation energy levels of the molecular hydrino gas, and laser optics.

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

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

reactants capable of undergoing a reaction that produces enough energy to form a plasma in the vessel comprising:

a) a mixture of hydrogen gas and oxygen gas, and/or

water vapor, and/or

a mixture of hydrogen gas and water vapor;

b) a molten metal;

a mass flow controller to control the flow rate of at least one reactant into the vessel;

a vacuum pump to maintain the pressure in the vessel below atmospheric pressure when one or more reactants are flowing into the vessel;

a molten metal injector system comprising at least one reservoir that contains some of the molten metal, a molten metal pump system (*e.g.*, one or more electromagnetic pumps) configured to deliver the molten metal in the reservoir and through an injector tube to provide a molten metal stream, and at least one non-injector molten metal reservoir for receiving the molten metal stream;

at least one ignition system comprising a source of electrical power or ignition current to supply electrical power to the at least one stream of molten metal to ignite the reaction when the hydrogen gas and/or oxygen gas and/or water vapor are flowing into the vessel;

a reactant supply system to replenish reactants that are consumed in the reaction;

a power converter or output system to convert a portion of the energy produced from the reaction (*e.g.*, light and/or thermal output from the plasma) to electrical power and/or thermal power.

Power systems (herein also referred to as “SunCells”) of the present disclosure may comprise:

a.) at least one vessel capable of a maintaining a pressure below atmospheric comprising a reaction chamber;

b) two electrodes configured to allow a molten metal flow therebetween to complete a circuit;

c) a power source connected to said two electrodes to apply a current therebetween when said circuit is closed;

d) a plasma generation cell (e.g., glow discharge cell) to induce the formation of a first plasma from a gas; wherein effluence of the plasma generation cell is directed towards the circuit (e.g., the molten metal, the anode, the cathode, an electrode submerged in a molten metal reservoir);

wherein when current is applied across the circuit, the effluence of the plasma generation cell undergoes a reaction to producing a second plasma and reaction products; and

e) a power adapter configured to convert and/or transfer energy from the second plasma into mechanical, thermal, and/or electrical energy. In some examples, the gas in the plasma generation cell is a mixture of hydrogen (H_2) and oxygen (O_2). For example, the relative molar ratio of oxygen to hydrogen is from 0.01%-50% (*e.g.* from 0.1%-20%, from 0.1-15%, etc.). In certain implementations, the molten metal is Gallium. In some examples, the reaction products have at least one spectroscopic signature as described herein (*e.g.*, those described in Example 10). In various examples, the second plasma is formed in a reaction cell, and the walls of said reaction cell comprise a liner having increased resistance to alloy formation (*e.g.*, alloy formation with the molten metal such as Gallium) with the molten metal and the liner and the walls of the reaction cell have a high permability to the reaction products (*e.g.* stainless steel such as 347 SS such as 4130 alloy SS or Cr-Mo SS, nickel, Ti, niobium, vanadium, iron, W, Re, Ta, Mo, niobium, and Nb(94.33 wt%)-Mo(4.86 wt%)-Zr(0.81 wt%)). The liner may be made of a crystalline material (*e.g.*, SiC, BN, quartz) and/or a refractory metal such as at least one of Nb, Ta, Mo, or W. In certain embodiments, the second plasma is formed in a reaction cell, wherein the walls reaction cell chamber comprise a first and a second section,

the first section composed of stainless steel such as 347 SS such as 4130 alloy SS or Cr-Mo SS, nickel, Ti, niobium, vanadium, iron, W, Re, Ta, Mo, niobium, and Nb(94.33 wt%)-Mo(4.86 wt%)-Zr(0.81 wt%);

the second section comprising a refractory metal different than the metal in the first section;

wherein the union between the different metals is formed by a lamination material (*e.g.*, a ceramic such as BN).

A power system of the present disclosure may include:

a.) a vessel capable of a maintaining a pressure below atmospheric comprising a reaction chamber;

b) a plurality of electrode pairs, each pair comprising electrodes configured to allow a molten metal flow therebetween to complete a circuit.

c) a power source connected to said two electrodes to apply a current therebetween when said circuit is closed;

d) a plasma generation cell (e.g., glow discharge cell) to induce the formation of a first plasma from a gas; wherein effluence of the plasma generation cell is directed towards the circuit (e.g., the molten metal, the anode, the cathode, an electrode submerged in a molten metal reservoir);

wherein when current is applied across the circuit, the effluence of the plasma generation cell undergoes a reaction to producing a second plasma and reaction products; and

e) a power adapter configured to convert and/or transfer energy from the second plasma into mechanical, thermal, and/or electrical energy;

wherein at least one of the reaction products (*e.g.*, intermediates, final products) has at least one spectroscopic signature as described herein (*e.g.*, as shown in Example 10).

The power system may comprise a gas mixer for mixing the hydrogen and oxygen gases and/or water molecules and a hydrogen and oxygen recombiner and/or a hydrogen dissociator. In some examples, the the hydrogen and oxygen recombiner comprises a plasma cell. The plasma cell may comprise a center positive electrode and a grounded tubular body counter electrode wherein a voltage (*e.g.* ,a voltage in the range of 50 V to 1000 V) is applied across the electrodes to induce the formation of a plasma from a hydrogen (H_2) and oxygen (O_2) gas mixture. In some examples, the hydrogen and oxygen recombiner comprises a recombiner catalytic metal supported by an inert support material. In certain implementations, the gas mixture supplied to the plasma generation cell to produce the first plasma comprises a non-stoichiometric H_2/O_2 mixture (*e.g.*, an H_2/O_2 mixture having less than 1/3 mole % O_2 or from 0.01% to 30%, or from 0.1% to 20%, or less than 10%, or less than 5%, or less than 3% O_2 by mole percentage of the mixture) that is flowed through the plasma cell (*e.g.*, a glow discharge cell) to create a reaction mixture capable of undergoing the reaction with sufficient exothermicity to produce the second plasma. A non-stoichiometric H_2/O_2 mixture may pass through the glow discharge to produce an effluence of atomic hydrogen and nascent H_2O (*e.g.*, a mixture having water at a concentration and with an internal energy sufficient to prevent formation of hydrogen bonds);
the glow discharge effluence is directed into a reaction chamber where the ignition current is supplied between two electrodes (*e.g.*, with a molten metal passed therebetween), and upon interaction of the effluence with the biased molten metal (*e.g.*, gallium), the reaction between

the nascent water and the atomic hydrogen is induced, for example, upon the formation of arc current.

The power system may comprise at least one of the reaction chamber (*e.g.* where the nascent water and atomic hydrogen undergo the plasma forming reaction) and/or reservoir comprising at least one refractory material liner that is resistant to forming an alloy with the molten metal. The inner wall of the reaction chamber may comprise a ceramic coating, a carbon liner lined with a W, Nb, or Mo liner, lined with W plates. In some examples, the reservoir comprises a carbon liner and the carbon is covered by the molten metal contained therein. In various implementations, the reaction chamber wall comprises a material that is highly permeable to the reaction product gas. In various examples, the reaction chamber wall comprises at least one of stainless steel (*e.g.*, Mo-Cr stainless steel), niobium, molybdenum, or tungsten.

The power system may comprise a a condenser to condense molten metal vapor and metal oxide particles and vapor and returns them to the reaction cell chamber. In some examples, the power system may further comprise a vacuum line wherein the condenser comprises a section of the vacuum line from the reaction cell chamber to the vacuum pump that is vertical relative to the reaction cell chamber and comprises an inert, high-surface area filler material that condenses the molten metal vapor and metal oxide particles and vapor and returns them to the reaction cell chamber while permitting the vacuum pump to maintain a vacuum pressure in the reaction cell chamber.

The power system may comprise a blackbody radiator and a window to output light from the blackbody radiator. Such embodiments may be used to generate light (*e.g.*, used for lighting).

In some examples, the power system may further comprise a gas mixer for mixing the hydrogen and oxygen gases and a hydrogen and oxygen recombiner and/or a hydrogen dissociator. For example, the power system may comprise a hydrogen and oxygen recombiner wherein the hydrogen and oxygen recombiner comprises a recombiner catalytic metal supported by an inert support material.

The power system may be operated with parameters that maximize reactions, and specifically, reactions capable of outputting enough energy to sustain plamsa generation and net energy output. For example, in some examples, the pressure of the vessel during operation is in the range of 0.1 Torr to 50 Torr. In certain implementations, the hydrogen mass flow rate exceeds that of the oxygen mass flow rate by a factor in the range of 1.5 to 1000. In some examples, the pressure may be over 50 Torr and may further comprise a gas recirculation system.

In some examples, an inert gas (*e.g.*, argon) is injected into the vessel. The inert gas may be used to prolong the lifetime of certain *in situ* formed reactants (such as nascent water).

The power system may comprise a water micro-injector configured to inject water into the vessel such that the plasma produced from the energy output from the reaction comprises water vapor. In some examples, the micro-injector injects water into the vessel. In some examples, the H_2 molar percentage is in the range of 1.5 to 1000 times the molar percent of the water vapor (*e.g.*, the water vapor injected by the micro-injector).

The power system may further comprise a heater to melt a metal (*e.g.*, gallium or silver or copper or combinations thereof) to form the molten metal. The power system may further comprise a molten metal recovery system configured to recover molten metal after the reaction comprising a molten metal overflow channel which collects overflow from the non-injector molten metal reservoir.

The molten metal injection system may further comprise electrodes in the molten metal reservoir and the non-injection molten metal reservoir; and the ignition system comprises a source of electrical power or ignition current to supply opposite voltages to the injector and non-injector reservoir electrodes; wherein the source of electrical power supplies current and power flow through the stream of molten metal to cause the reaction of the reactants to form a plasma inside of the vessel.

The source of electrical power typically delivers a high-current electrical energy sufficient to cause the reactants to react to form plasma. In certain examples, the source of electrical power comprises at least one supercapacitor. In various implementations, the current from the molten metal ignition system power is in the range of 10 A to 50,000 A.

Typically, the molten metal pump system is configured to pump molten metal from a molten metal reservoir to a non-injection reservoir, wherein a stream of molten metal is created therebetween. In some embodiments, the molten metal pump system is one or more electromagnetic pumps and each electromagnetic pump comprises one of a

a) DC or AC conduction type comprising a DC or AC current source supplied to the molten metal through electrodes and a source of constant or in-phase alternating vector-crossed magnetic field, or

b) induction type comprising a source of alternating magnetic field through a shorted loop of molten metal that induces an alternating current in the metal and a source of in-phase alternating vector-crossed magnetic field.

In some examples, the circuit of the molten metal ignition system is closed by the molten metal stream to cause ignition to further cause ignition (*e.g.*, with an ignition frequency less than 10,000 Hz). The injector reservoir may comprise an electrode in contact with the molten

metal therein, and the non-injector reservoir comprises an electrode that makes contact with the molten metal provided by the injector system.

In various implementations, the non-injector reservoir is aligned above (e.g., vertically with) the injector and the injector is configured to produce the molten stream orientated towards the non-injector reservoir such that molten metal from the molten metal stream may collect in the reservoir and the molten metal streammakes electrical contact with the non-injector reservoir electrode; and wherein the molten metal pools on the non-injector reservoir electrode. In certain examples, the ignition current to the non-injector reservoir may comprise:

a) a hermitically sealed, high-temperature capable feed though that penetrates the vessel;

b) an electrode bus bar, and

c) an electrode.

The ignition current density may be related to the vessel geometry for at least the reason that the vessel geometry is related to the ultimate plasma shape. In various implementations, the vessel may comprise an hourglass geometry (*e.g.*, a geometry wherein a middle portion of the internal surface area of the vessel has a smaller cross section than the cross section within 20% or 10% or 5% of each distal end along the major axis) and oriented in a vertical orientation (*e.g.*, the major axis approximately parallel with the force of gravity) in cross section wherein the injector reservoir is below the waist and configured such that the level of molten metal in the reservoir is about proximal to the waist of the hourglass to increase the ignition current density. In some examples, the vessel is symmetric about the major longitudinal axis. In some examples, the vessel may an hourglass geometry and comprise a refractory metal liner. In some examples, the injector reservoir of the vessel having an hourglass geometry may comprise the positive electrode for the ignition current.

The molten metal may comprise at least one of silver, gallium, silver-copper alloy, copper, or combinations thereof. In some examples, the molten metal has a melting point below 700 °C. For example, the molten metal may comprise at least one of bismuth, lead, tin, indium, cadmium, gallium, antimony, or alloys such as Rose's metal, Cerrosafe, Wood's metal, Field's metal, Cerrolow 136, Cerrolow 117, Bi-Pb-Sn-Cd-In-Tl, and Galinstan. In certain examples, at least one of component of the power generation system that contacts that molten metal (*e.g.*, reservoirs, electrodes) comprises, is clad with, or is coated with one or more alloy resistant material that resists formation of an alloy with the molten metal. Exemplary alloy resistant materials are W, Ta, Mo, Nb, Nb(94.33 wt%)-Mo(4.86 wt%)-Zr(0.81 wt%), Os, Ru, Hf, Re, 347 SS, Cr-Mo SS, silicide coated, carbon, and a ceramic such

as BN, quartz, Si3N4, Shapal, AlN, Sialon, Al_2O_3, ZrO_2, or HfO_2. In some examples, at least a portion of the vessel is composed of a ceramic and/or a metal. The ceramic may comprise at least one of a metal oxide, quartz, alumina, zirconia, magnesia, hafnia, silicon carbide, zirconium carbide, zirconium diboride, silicon nitride, and a glass ceramic. In some examples, the metal of the vessel comprises at least one of a stainless steel and a refractory metal.

The molten metal may react with water to form atomic hydrogen *in situ*. In various implementations, the molten metal is gallium and the power system further comprises a gallium regeneration system to regenerate gallium from gallium oxide (*e.g.*, gallium oxide produced in the reaction). The gallium regeneration system may comprise a source of at least one of hydrogen gas and atomic hydrogen to reduce gallium oxide to gallium metal. In some examples, hydrogen gas is delivered to the gallium regeneration system from sources external to the power generation system. In some examples, hydrogen gas and/or atomic hydrogen are generated *in situ*. The gallium regeneration system may comprise an ignition system that delivers electrical power to gallium (or gallium/gallium oxide combinations) produced in the reaction. In several implementations, such electrical power may electrolyze gallium oxide on the surface of gallium to gallium metal. In some embodiments, the gallium regeneration system may comprise an electrolyte (*e.g.*, an electrolyte comprising an alkali or alkaline earth halide). In some examples, the gallium regeneration system may comprise a basic pH aqueous electrolysis system, a means to transport gallium oxide into the system, and a means to return the gallium to the vessel (*e.g.*, to the molten metal reservoir). In some examples, the gallium regeneration system comprises a skimmer and a bucket elevator to remove gallium oxide from the surface of gallium. In various implementations, the power system may comprise an exhaust line to the vacuum pump to maintain an exhaust gas stream and further comprising an electrostatic precipitation system in the exhaust line to collect gallium oxide particles in the exhaust gas stream.

In some examples, the power generation system generates a water/hydrogen mixture to be directed towards the molten metal cell through a plasma generation cell. In these examples, the plasma generation cell such as a glow discharge cell induce the formation of a first plasma from a gas (*e.g.*, a gas comprising a mixture oxygen and hydrogen); wherein effluence of the plasma generation cell is directed towards the any part of the molten metal circuit (*e.g.*, the molten metal, the anode, the cathode, an electrode submerged in a molten metal reservoir). Upon interaction of the biased molten metal with this effluence, a second plasma (more energetic than that created by the plasma generation cell) may be formed. In these examples, the plasma generation cell may be fed hydrogen (H_2) and oxygen mixtures (O_2) having a molar excess of hydrogen such that the effluence comprises atomic hydrogen (H) and water (H_2O). The water in the effluence may be in the

form of nascent water, water sufficiently energized and at a concentration such that it is not hydrogen bonded to other components in the effluence. This effluence may proceed in a second more energetic reaction involving the H and HOH that forms a plasma that intensifies upon interaction with the molten metal and a supplied external current through at least one of the molten metal and the plasma that may produce additional atomic hydrogen (from the H_2 in the effluence) to further propagate the second energetic reaction.

In some examples, the power system may further comprise at least one heat exchanger (*e.g.*, a heat exchanger coupled to a wall of the vessel wall, a heat exchanger which may transfer heat to or from the molten metal or to or from the molten metal reservoir). In some examples, the heat exchanger comprises one of a (i) plate, (ii) block in shell, (iii) SiC annular groove, (iv) SiC polyblock, and (v) shell and tube heat exchanger. In certain implementations, the shell and tube heat exchanger comprises conduits, manifolds, distributors, a heat exchanger inlet line, a heat exchanger outlet line, a shell, an external coolant inlet, an external coolant outlet, baffles, at least one pump to recirculate the hot molten metal from the reservoir through the heat exchanger and return the cool molten metal to the reservoir, and one or more a water pumps and water coolant or one or more air blowers and air coolant to flow cold coolant through the external coolant inlet and shell wherein the coolant is heated by heat transfer from the conduits and exists the external coolant outlet. In some examples, the shell and tube heat exchanger comprise conduits, manifolds, distributors, a heat exchanger inlet line, and a heat exchanger outlet line comprising carbon that line and expand independently of conduits, manifolds, distributors, a heat exchanger inlet line, a heat exchanger outlet line, a shell, an external coolant inlet, an external coolant outlet, and baffles comprising stainless steel. The external coolant of the heat exchanger comprises air, and air from a microturbine compressor or a microturbine recuperator forces cool air through the external coolant inlet and shell wherein the coolant is heated by heat transfer from the conduits and exists the external coolant outlet, and the hot coolant output from the external coolant outlet flows into a microturbine to convert thermal power to electricity.

In some examples, the power system comprises at least one power converter or output system of the reaction power output comprises at least one of the group of a thermophotovoltaic converter, a photovoltaic converter, a photoelectronic converter, a magnetohydrodynamic converter, a plasmadynamic converter, a thermionic converter, a thermoelectric converter, a Sterling engine, a supercritical CO_2 cycle converter, a Brayton cycle converter, an external-combustor type Brayton cycle engine or converter, a Rankine cycle engine or converter, an organic Rankine cycle converter, an internal-combustion type engine, and a heat engine, a heater, and a boiler. The vessel may comprise a light transparent photovoltaic (PV) window to transmit light from the inside of the vessel to a photovoltaic converter and at least one of a vessel geometry and at least one baffle comprising a spinning window. The spinning window comprises a system to reduce gallium oxide comprising at

least one of a hydrogen reduction system and an electrolysis system. In some examplesthe spinning window comprises or is composed of quartz, sapphire, magnesium fluoride, or combinations thereof. In several implementations, the spinning window is coated with a coating that suppresses adherence of at least one of gallium and gallium oxide. The spinning window coating may comprise at least one of diamond like carbon, carbon, boron nitride, and an alkali hydroxide. In some examples, the positive ignition electrode (*e.g.*, the top ignition electrode, the electrode displaced above the the other electrode) is closer to the window (*e.g.*, as compared to the negative ignition electrode) and the positive electrode emits blackbody radiation through the photovoltaic to the photovoltaic converter.

The power converter or output system may comprise a magnetohydrodynamic (MHD) converter comprising a nozzle connected to the vessel, a magnetohydrodynamic channel, electrodes, magnets, a metal collection system, a metal recirculation system, a heat exchanger, and optionally a gas recirculation system. In some examples, the molten metal may comprise silver. In exampleswith a magnetohydrodyanamic converter, the magnetohydrodynamic converter may be delivered oxygen gas to form silver particles nanoparticles (*e.g.*, of size in the molecular regime such as less than about 10 nm or less than about 1 nm) upon interaction with the silver in the molten metal stream, wherein the silver nanoparticles are accelerated through the magnetohydrodynamic nozzle to impart a kinetic energy inventory of the power produced from the reaction. The reactant supply system may supply and control delivery of the oxygen gas to the converter. In various implementations, at least a portion of the kinetic energy inventory of the silver nanoparticles is converted to electrical energy in a magnetohydrodynamic channel. Such version of electrical energy may result in coalescence of the nanoparticles. The nanoparticles may coalesce as molten metal which at least partially absorbs the oxygen in a condensation section of the magnetohydrodynamic converter (also referred to herein as an MHD condensation section) and the molten metal comprising absorbed oxygen is returned to the injector reservoir by a metal recirculation system. In some examples, the oxygen may be released from the metal by the plasma in the vessel. In some examples, the plasma is maintained in the magnetohydrodynamic channel and metal collection system to enhance the absorption of the oxygen by the molten metal.

The molten metal pump system may comprise a first stage electromagnetic pump and a second stage electromagnetic pump, wherein the first stage comprises a pump for a metal recirculation system, and the second stage that comprises the pump of the metal injector system.

The reaction induced by the reactants produces enough energy in order to initiate the formation of a plasma in the vessel. The reactions may produce a hydrogen product characterized as one or more of:

separation of 1.028 Å ±10% and/or a calorimetric determination of the energy of vaporization of 0.0011 eV ±10% per molecular hydrogen;

bb) a solid hydrogen product having FTIR and Raman spectral signatures of (i) (J+1)44.30 cm^{-1} ±20 cm^{-1}, (ii) (J+1)22.15 cm^{-1} ±10 cm^{-1} and (iii) 23 cm^{-1} ±10% and/or an X-ray or neutron diffraction pattern showing a hydrogen molecule separation of 1.028 Å ±10% and/or a calorimetric determination of the energy of vaporization of 0.019 *eV* ±10% per molecular hydrogen.

cc) a hydrogen product comprising a hydrogen hydride ion that is magnetic and links flux in units of the magnetic in its bound-free binding energy region, and

dd) a hydrogen product wherein the high pressure liquid chromatography (HPLC) shows chromatographic peaks having retention times longer than that of the carrier void volume time using an organic column with a solvent comprising water wherein the detection of the peaks by mass spectroscopy such as ESI-ToF shows fragments of at least one inorganic compound.

In various implementations, the hydrogen product may be characterized similarly as products formed from various hydrino reactors such as those formed by wire detonation in an atmosphere comrpsing water vapor. Such products may:

a) comprise at least one of a metal hydride and a metal oxide further comprising hydrogen wherein the metal comprises at least one of Zn, Fe, Mo, Cr, Cu, and W and the hydrogen comprises H;

b) comprise an inorganic compound M_xX_y and H_2 wherein M is a metal cation and X is an anion and at least one of the electrospray ionization time of flight secondary ion mass spectrum (ESI-ToF) and the time of flight secondary ion mass spectrum (ToF-SIMS) comprises peaks of $M(M_xX_yH(1/4)_2)n$ wherein n is an integer;

c) be magnetic and comprise at least one of a metal hydride and a metal oxide further comprising hydrogen wherein the metal comprises at least one of Zn, Fe, Mo, Cr, Cu, W, and a diamagnetic metal, and the hydrogen is H(1/4), and

d) comprise at least one of a metal hydride and a metal oxide further comprising hydrogen wherein the metal comprises at least one of Zn, Fe, Mo, Cr, Cu, W, and a diamagnetic metal and H is H(1/4) wherein the product demonstrates magnetism by magnetic susceptometry.

In some examples, the hydrogen product formed by the reaction comprises the hydrogen product complexed with at least one of (i) an element other than hydrogen, (ii) an ordinary hydrogen species comprising at least one of H^+, ordinary H_2, ordinary H^-, and

ordinary H_3^+, an organic molecular species, and (iv) an inorganic species. In some examples, the hydrogen product comprises an oxyanion compound. In various implementations, the hydrogen product (or a recovered hydrogen product from examples comprising a getter) may comprise at least one compound having the formula selected from the group of:

a) MH, MH_2, or M_2H_2, wherein M is an alkali cation and H or H_2 is the hydrogen product;

b) MH_n wherein n is 1 or 2, M is an alkaline earth cation and H is the hydrogen product;

c) MHX wherein M is an alkali cation, X is one of a neutral atom such as halogen atom, a molecule, or a singly negatively charged anion such as halogen anion, and H is the hydrogen product;

d) MHX wherein M is an alkaline earth cation, X is a singly negatively charged anion, and H is H is the hydrogen product;

e) MHX wherein M is an alkaline earth cation, X is a double negatively charged anion, and H is the hydrogen product;

f) M_2HX wherein M is an alkali cation, X is a singly negatively charged anion, and H is the hydrogen product;

g) MH_n wherein n is an integer, M is an alkaline cation and the hydrogen content H_n of the compound comprises at least one of the hydrogen products;

h) M_2H_n wherein n is an integer, M is an alkaline earth cation and the hydrogen content H_n of the compound comprises at least of the hydrogen products;

i) M_2XH_n wherein n is an integer, M is an alkaline earth cation, X is a singly negatively charged anion, and the hydrogen content H_n of the compound comprises at least one of the hydrogen products;

j) $M_2X_2H_n$ wherein n is 1 or 2, M is an alkaline earth cation, X is a singly negatively charged anion, and the hydrogen content H_n of the compound comprises at least one of the hydrogen products;

k) M_2X_3H wherein M is an alkaline earth cation, X is a singly negatively charged anion, and H is the hydrogen product;

l) M_2XH_n wherein n is 1 or 2, M is an alkaline earth cation, X is a double negatively charged anion, and the hydrogen content H_n of the compound comprises at least one of the hydrogen products;

w) $\left(MHMNO_3\right)_n$ wherein M is an alkali cation or other +1 cation, n is an integer and the hydrogen content H of the compound comprises at least one of the hydrogen products;

x) $\left(MHMOH\right)_n$ wherein M is an alkali cation or other +1 cation, n is an integer, and the hydrogen content H of the compound comprises at least one of the hydrogen products;

y) $\left(MH_mM'X\right)_n$ wherein m and n are each an integer, M and M' are each an alkali or alkaline earth cation, X is a singly or double negatively charged anion, and the hydrogen content H_m of the compound comprises at least one of the hydrogen products; and

z) $\left(MH_mM'X'\right)_n^+ \; nX^-$ wherein m and n are each an integer, M and M' are each an alkali or alkaline earth cation, X and X' are a singly or double negatively charged anion, and the hydrogen content H_m of the compound comprises at least one of the hydrogen products.

The anion of the hydrogen product formed by the reaction may be one or more singly negatively charged anions including a halide ion, a hydroxide ion, a hydrogen carbonate ion, a nitrate ion, a double negatively charged anions, a carbonate ion, an oxide, and a sulfate ion. In some examples, the hydrogen product is embedded in a crystalline lattice (*e.g.*, with the use of a getter such as K_2CO_3 located, for example, in the vessel or in an exhaust line). For example, the hydrogen product may be embedded in a salt lattice. In various implementations, the salt lattice may comprise an alkali salt, an alkali halide, an alkali hydroxide, alkaline earth salt, an alkaline earth halide, an alkaline earth hydroxide, or combinations thereof.

In an example, electrode systems are also provided comprising:

a) a first electrode and a second electrode;

b) a stream of molten metal (*e.g.*, molten silver, molten gallium) in electrical contact with said first and second electrodes;

c) a circulation system comprising a pump to draw said molten metal from a reservoir and convey it through a conduit (*e.g.*, a tube) to produce said stream of molten metal exiting said conduit;

d) a source of electrical power configured to provide an electrical potential difference between said first and second electrodes;

wherein said stream of molten metal is in simultaneous contact with said first and second electrodes to create an electrical current between said electrodes. In some examples, the electrical power is sufficient to create a current in excess of 100 A.

In an example, electrical circuits are also provided which may comprise:

a) a heating means for producing molten metal;

b) a pumping means for conveying said molten metal from a reservoir through a conduit to produce a stream of said molten metal exiting said conduit;

c) a first electrode and a second electrode in electrical communication with a power supply means for creating an electrical potential difference across said first and second electrode;

wherein said stream of molten metal is in simultaneous contact with said first and second electrodes to create an electrical circuit between said first and second electrodes. For example, in an electrical circuit comprising a first and second electrode, the improvement may comprise passing a stream of molten metal across said electrodes to permit a current to flow there between.

Additionally, systems for producing a plasma (which may be used in the power generation systems described herein) are provided. These systems may comprise:

a) a molten metal injector system configured to produce a stream of molten metal from a metal reservoir;

b) an electrode system for inducing a current to flow through said stream of molten metal;

c) at least one of a (i) water injection system configured to bring a metered volume of water in contact with said molten metal, wherein a portion of said water and a portion of said molten metal react to form an oxide of said metal and hydrogen gas, (ii) a mixture of excess hydrogen gas an oxygen gas, and (iii) a mixture of excess hydrogen gas and water vapor, and

d) a power supply configured to supply said current;

wherein said plasma is produced when current is supplied through said metal stream. In some examples, the system may further comprise:

a pumping system configured to transfer metal collected after the production of said plasma to said metal reservoir. In some examples, the system may comprise:

a metal regeneration system configured to collect said metal oxide and convert said metal oxide to said metal; wherein said metal regeneration system comprises an anode, a

a) two electrodes configured to allow a molten metal flow therebetween to complete a circuit;

b) a power source connected to said two electrodes to apply a current therebetween when said circuit is closed;

c) a recombiner cell (*e.g.*, glow discharge cell) to induce the formation of nascent water and atomic hydrogen from a gas; wherein effluence of the recombiner is directed towards the circuit (*e.g.*, the molten metal, the anode, the cathode, an electrode submerged in a molten metal reservoir);

wherein when current is applied across the circuit, the effluence of the recombiner cell undergoes a reaction to produce a plasma. In some examples, the system is used to generate heat from the plasma. In various implementations, the system is used to generate light from the plasma.

The systems of the present disclosure may comprise (or be part of) a mesh network comprising a plurality of power-system-transmitter-receiver nodes that transmit and received electromagnetic signals in at least one frequency band, the frequency of the band may be high frequency due to the ability to position nodes locally with short separation distance wherein the frequency may be in at least one range of about 0.1 GHz to 500 GHz, 1 GHz to 250 GHz, 1 GHz to 100 GHz, 1 GHz to 50 GHz, and 1 GHz to 25 GHz.

The unique spectroscopic signatures measured in the reaction products produces hydrogen products with unique characteristics. These hydrogen reaction products may be used in various devices, each part of the the present disclosure.

The present disclosure also embraces superconducting quantum interference devices (SQUIDs) or SQUID-type electronic elements which may comprise at least one hydrino species $H^-\left(1/p\right)$ and $H_2\left(1/p\right)$ (or species having spectroscopic features that match these species) and at least one of an input current and input voltage circuit and an output current and output voltage circuit to at least one of sense and change the flux linkage state of at least one of the hydrino hydride ion and molecular hydrino. In some examples, the circuits comprise AC resonant circuits comprising radio frequency RLC circuits. In various implementations, the SQUIDs or SQUID-type electronic element further comprises at least one source of electromagnetic radiation (*e.g.*, a source of at least one of microwave, infrared, visible, or ultraviolet radiation) to, for example, induce a magnetic field in a sample. In some

examples, the the source of radiation comprises a laser or a microwave generator. The laser radiation may be applied in a focused manner by lens or fiber optics (*e.g.* to a sample of interest). In some examples, the SQUID or SQUID-type electronic element further comprises a source of magnetic field applied to at least one of the hydrino hydride ion and molecular hydrino. The magnetic field may be tunable. Such tunability of at least one of the source of radiation and magnetic field may enables the selective and controlled achievement of resonance between the source of electromagnetic radiation and the magnetic field. The SQUID or SQUID-type electronic element may comprise a computer logic gate, memory element, and other electronic measurement or actuator devices such as magnetometers, sensors, and switches that operates at elevated temperature.

A SQUID of the present disclosure may comprise: at least two Josephson junctions electrically connected to a superconducting loop,

wherein the Josephson Junction comprising a hydrogen species H_2 that is EPR active. In certain embodiments, the hydrogen species is MOOH:H_2, wherein M is a metal (*e.g.*, Ag, Ga).

The present reaction products produced, for example, from the operation of power generation systems of the disclosure may be used as or in a cryogen, a gaseous heat transfer agent, and/or an agent for buoyancy comprising molecular hydrino (*e.g.*, species having spectroscopic features that match molecular hydrino).

MRI gas contrast agents are also provided comprising molecular hydrino (*e.g.*, species having spectroscopic features that match molecular hydrino).

The reaction products also may be used as the excitation medium in lasers. The disclosure embraces hydrino molecular gas laser which may comprise molecular hydrino gas ($H_2(1/p)$ p =2,3,4,5,…,137) (*e.g.*, species having spectroscopic features that match molecular hydrino), a laser cavity containing the molecular hydrino gas, a source of excitation of rotation energy levels of the molecular hydrino gas, and laser optics. In some examples, the laser optics comprise mirrors at the ends of the cavity comprising molecular hydrino gas in excited rotational states, and one of the mirrors is semitransparent to permit the laser light to be emitted from the cavity. In various implemenations, the source of excitation comprises at least one of a laser, a flash lamp, a gas discharge system (e.g. a glow, microwave, radio frequency (RF), inductively couples RF, capacitively coupled RF, or other plasma discharge system). In certain examples, the laser may further comprise an external or internal field source

(e.g., a source of electric or magnetic field) to cause at least one desired molecular hydrino rotational energy level to be populated wherein the level comprises at least one of a desired spin-orbital and fluxon linkage energy shift. The laser transition may occur between an inverted population of a selected rotational state to that of lower energy that is less populated. In some examples, the laser cavity, optics, excitation source, and external field source are selected to achieve the desired inverted population and stimulated emission to the desired less populated lower-energy state. The laser may comprise a solid laser medium. For example, the solid laser medium comprises molecular hydrino trapped in a solid matrix wherein the hydrino molecules may be free rotors and the solid medium replaces the gas cavity of a molecular hydrino gas laser. In certain implementations, the solid lasing media comprises at least one of GaOOH:H_2(1/4), KCl:H_2(1/4), and silicon having trapped molecular hydrino (*e.g.*, Si(crystal):H_2(1/4)) (or species having spectroscopic signatures thereof).

Methods are also provided. The method may, for example, generate power or produce light, or product a plasma. In some examples, the method comprises:

a) electrically biasing a molten metal;

b) directing the effluence of a plasma generation cell (*e.g.*, a glow discharge cell) to interact with the biased molten metal and induce the formation of a plasma. In certain implementations, the effluence of the plasma generation cell is generated from a hydrogen (H_2) and oxygen (O_2) gas mixture passing through the plasma generation cell during operation.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several embodiments of the disclosure and together with the description, serve to explain the principles of the disclosure. In the drawings:

Figure 1 is a schematic drawing of magnetohydrodynamic (MHD) converter components of a cathode, anode, insulator, and bus bar feed-through flange in accordance with an embodiment of the present disclosure.

Figures 2-3 are schematic drawings of a SunCell® power generator comprising dual EM pump injectors as liquid electrodes showing tilted reservoirs and a magnetohydrodynamic (MHD) converter comprising a pair of MHD return EM pumps in accordance with an embodiment of the present disclosure.

Figure 4 is schematic drawings of a single-stage induction injection EM pump in accordance with an embodiment of the present disclosure.