cavity of the canister and is in contact with said fuel; insulation in contact with the external surface of said canister and the internal surface of said gas-tight enclosure; and, wherein hydrogen gas is produced by heating to cause decomposition of fuel. In one aspect, there is provided a thermolysis hydrogen fuel cartridge comprising: a gas-tight enclosure with a first external surface (20/21/22) and a first internal surface; a canister (102A) disposed within the gas-tight enclosure and characterized by a wall that has a second external surface, and a second internal surface (102B) , forming a cavity; a fuel (104/501) in the cavity of the canister; vacuum insulation (101) in contact with the external surface of said canister and the internal surface of said gas-tight enclosure; a heating element (103) with an electrical connection (37) that extends from the external surface of said cartridge (24) through the vacuum insulation into the cavity of the canister and is in contact with said fuel; wherein the heating element is configured to heat said fuel and cause decomposition of said fuel to produce hydrogen gas.

[0008] In some exemplary implementation of the disclosure, the thermolysis fuel includes at least one of alane and ammonia borane. In some exemplary implementation of the disclosure, the thermolysis fuel includes at least some inert materials to improve thermal conductivity including at least one of alumina and ceramics. In some exemplary implementation of the disclosure, the thermolysis is admixed with metal powders such as aluminum to improve thermal conductivity.

[0009] In some exemplary implementation of the disclosure, the thermolysis cartridge includes a fluid communication means wherein hydrogen may be output from the cartridge. In some exemplary implementation of the disclosure, the thermolysis cartridge heating element is a bendable element. In some exemplary implementation of the disclosure, the thermolysis cartridge heating element is discrete elements and in some instances the discrete elements are banked and one or more discrete elements are switched on/off for proportional control.

[0010] According to some exemplary implementation of the disclosure, a thermolysis cartridge comprising an enclosure with an external surface and an internal surface; a canister characterized by a wall that has an external surface forming a cavity; a fuel in the cavity of the canister; a heating element with an electrical connection that extends through the face of the enclosure and surrounds at least a portion of the canister; a

hydrogen output port extending from the canister; insulation in contact with the external surface of the canister; and, wherein hydrogen gas is produced by heating to cause decomposition of fuel and output via a port. In another aspect, there is provided a thermolysis hydrogen fuel cartridge comprising: an enclosure (310/312) with a first external surface (310) and a first internal surface; a canister (302/402) disposed within the gas-tight enclosure and characterized by a wall that has a second external surface (305/407) forming a cavity; a fuel (104/404) in the cavity of the canister; vacuum insulation (301/401) in contact with the external surface of the canister; a heating element (303/403) with an electrical connection (315) that extends through the face (312) of the enclosure and the vacuum insulation and surrounds at least a portion of the canister; a hydrogen output port (306/406) extending from the canister; wherein the heating element is configured to heat said fuel and cause decomposition of said fuel to produce hydrogen gas and output the produced hydrogen gas via the hydrogen output port.

[0011] In some exemplary implementation of the disclosure, the canister includes at least one of ceramics, plastics, laminates, foils, and metals. In some exemplary implementation of the disclosure the canister includes a manifold in fluid communication with the hydrogen output port. In some exemplary implementation of the disclosure the canister includes heat transfer members within the canister. In some instance the heat transfer members are fins. The fins, in some instance, extend radially from the center axis of the canister.

[0012] The fins, in some instances, extend inward from the annular wall towards the center axis of the canister. In some instances the heat transfer members are perforated plates placed inside the canister and orthogonal to the canister wall.

[0013] In some exemplary implementation of the disclosure, the canister includes compartmentalization of fuel within the canister. The compartmentalization may be accomplished via one or more of fins, perforated plates inside the canister and placed orthogonal to the canister wall. In some instance the disclosure provides discrete heating of compartmentalization of fuel within the canister.

[0014] In some exemplary implementation of the disclosure, heating element has local switchable regions. In some instances discrete heating elements are banked and one or more discrete elements are switched on/off for proportional control.

[0015] In some exemplary implementation of the disclosure, the thermolysis fuel includes at least one of alane and ammonia borane. In some exemplary implementation of the disclosure, the thermolysis fuel includes at least some inert materials to improve thermal conductivity including at least one of alumina and ceramics.

[0016] According to some exemplary implementation of the disclosure, there is a thermolysis hydrogen fuel cartridge comprising: an enclosure ; an encasement and an internal surface; a vacuum insulation forming a cavity which is substantially impermeable to hydrogen; a fuel in the cavity; a heating element within the cavity; a face plate forming the cartridge when affixed to the encasement; A communications ribbon extending through an aperture in the face plate in conductive communication with the heating element; and, fluid communication means whereby hydrogen gas is produced by heating to cause decomposition of fuel is output. In yet another aspect, there is provided a thermolysis hydrogen fuel cartridge comprising: an encasement (504) affixed to a face plate (508) to form a cartridge enclosure; a vacuum insulation (502) disposed within the enclosure and forming a cavity (600) which is substantially impermeable to hydrogen; a fuel (501) in the cavity; a heating element (503) within the cavity; a communications ribbon (505) extending through an aperture (507) in the face plate and the vacuum insulation, said communications ribbon being in conductive communication with the heating element; and, a fluid communication means whereby hydrogen gas is output; wherein the heating element is configured to heat said fuel and cause decomposition of said fuel to produce hydrogen gas.

DRAWINGS

[0017] FIG. 1 is a perspective view of an exemplary thermolysis fuel cartridge.

[0018] FIG. 2 is a cross sectional view of an exemplary thermolysis fuel cartridge showing a partial area of fuel.

[0019] FIG. 3 is a view of a flexible heating element for use in a thermolysis fuel cartridge.

[0020] FIG. 4 is a cut-out view of a cylindrical thermolysis fuel cartridge.

CLAIMS

1. A thermolysis hydrogen fuel cartridge comprising:

a gas-tight enclosure with ~~an~~ first external surface (20/21/22) and ~~an~~ first internal surface;

a canister (102A) disposed within the gas-tight enclosure and characterized by a wall that has ~~an~~ second external surface, and a second internal surface (102B) , forming a cavity;

a fuel (104/501) in the cavity of the canister;

vacuum insulation (101) in contact with the external surface of said canister and the internal surface of said gas-tight enclosure;

a heating element (103) with an electrical connection (37) that extends from the external surface of said cartridge (24) through the vacuum insulation into the cavity of the canister and is in contact with said fuel;

~~insulation (101) in contact with the external surface of said canister and the internal surface of said gas-tight enclosure; and,~~

wherein the heating element is configured to heat said fuel and ~~hydrogen gas is produced by heating to~~ cause decomposition of said fuel to produce hydrogen gas.

2. The thermolysis hydrogen fuel cartridge of claim 1, wherein said fuel includes at least one of alane and ammonia borane.

3. The thermolysis hydrogen fuel cartridge of claim 1, wherein said fuel includes at least some inert materials to improve thermal conductivity including at least one of alumina and ceramics.

4. The thermolysis hydrogen fuel cartridge of claim 1, wherein said fuel is admixed with metal powders such as aluminum to improve thermal conductivity.

5. The thermolysis hydrogen fuel cartridge of claim 1, further comprising a fluid communication means (35) wherein hydrogen may be output from the cartridge.

6. The thermolysis hydrogen fuel cartridge of claim 1, wherein said heating element is a bendable element.

7. The thermolysis hydrogen fuel cartridge of claim 1, wherein said heating element is discrete elements.

8. The thermolysis hydrogen fuel cartridge of claim 6, wherein said discrete elements are banked and one or more discrete elements are switched on/off for proportional control.

9. A thermolysis hydrogen fuel cartridge comprising:

an enclosure (310/312)~~;~~

~~———~~with a~~n~~ first external surface (310) and a~~n~~ first internal surface;

a canister (302/402) disposed within the gas-tight enclosure and characterized by a wall that has a~~n~~ second external surface (305/407) forming a cavity;

a fuel (104/404) in the cavity of the canister;

vacuum insulation (301/401) in contact with the external surface of the canister;

a heating element (303/403) with an electrical connection (315) that extends through the face (312) of the enclosure and the vacuum insulation and surrounds at least a portion of the canister;

a hydrogen output port (306/406) extending from the canister;

~~insulation (301/401) in contact with the external surface of the canister; and,~~

wherein the heating element is configured to heat said fuel and ~~hydrogen gas is produced by heating to~~ cause decomposition of said fuel to produce hydrogen gas and output the produced hydrogen gas via ~~a~~ the hydrogen output port ~~(306/406)~~.

10. The thermolysis hydrogen fuel cartridge of claim 9, wherein the canister includes at least one of ceramics, plastics, laminates, foils, and metals.

11. The thermolysis hydrogen fuel cartridge of claim 9, wherein said fuel includes at least one of alane and ammonia borane.

12. The thermolysis hydrogen fuel cartridge of claim 9, wherein said fuel includes at least some inert materials to improve thermal conductivity including at least one of alumina and ceramics.

13. The thermolysis hydrogen fuel cartridge of claim 9, further comprising a manifold within the canister and in fluid communication with the hydrogen output port.

24. The thermolysis hydrogen fuel cartridge of claim 23, wherein said discrete elements are banked and one or more discrete elements are switched on/off for proportional control.

25. A thermolysis hydrogen fuel cartridge comprising:

~~an enclosure (500);~~

an encasement (504) affixed to a face plate (508) to form a cartridge enclosure; ~~and an internal surface;~~

a vacuum insulation (502) disposed within the enclosure and forming a cavity (600) which is substantially impermeable to hydrogen;

a fuel (501) in the cavity;

a heating element (503) within the cavity;

~~a face plate (508) forming the cartridge when affixed to the encasement;~~

a communications ribbon (505) extending through an aperture (507) in the face plate and the vacuum insulation, said communications ribbon being in conductive communication with the heating element; and,

a fluid communication means whereby hydrogen gas is output;

wherein the heating element is configured to heat said fuel and ~~produced by heating to~~ cause decomposition of said fuel ~~is output~~ to produce hydrogen gas.

26. The thermolysis hydrogen fuel cartridge of claim 23, wherein said fuel includes at least one of alane and ammonia borane.

27. The thermolysis hydrogen fuel cartridge of claim 23, wherein said fuel includes at least some inert materials to improve thermal conductivity including at least one of alumina and ceramics.

28. The thermolysis hydrogen fuel cartridge of claim 25, wherein said heating element has local switchable regions.

29. The thermolysis hydrogen fuel cartridge of claim 28, wherein said discrete elements are banked and one or more discrete elements are switched on/off for proportional control.