

SUMMARY OF INVENTION

According to the invention in a first aspect, there is provided a cell for extracting energy from hydrogen atoms comprising:

a reaction vessel containing gaseous hydrogen atoms and a gaseous catalyst having a net enthalpy of reaction of about $27 * (p/2)$ eV, where p is an integer greater than 1, whereby said hydrogen atoms react with said catalyst in said vessel at a pressure less than atmospheric, thereby releasing energy and producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

According to the invention in a second aspect, there is provided a method for extracting energy from hydrogen comprising the steps of:

providing a gaseous catalyst having a net enthalpy of reaction of about $27 * (p/2)$ eV, where p is an integer greater than 1; providing gaseous hydrogen atoms; and reacting said gaseous catalyst with said gaseous hydrogen atoms, thereby producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1, said reaction occurring at a pressure less than atmospheric pressure.

5

The present invention comprises methods and apparatuses for releasing heat energy from hydrogen atoms (molecules) by stimulating their electrons to relax to quantized potential energy levels below that of the "ground state" via electron transfer reactions of reactants including electrochemical reactant(s) (electrocatalytic ion(s) or couple(s)) which remove energy from the hydrogen atoms (molecules) to stimulate these transitions. In addition, this application includes methods and apparatuses to enhance the power output by enhancing the reaction rate- the rate of the formation of the lower-energy hydrogen. The present invention further comprises a hydrogen spillover catalyst, a multifunctionality material having a functionality which dissociates molecular hydrogen to provide free hydrogen atoms which spill over to a functionality which supports mobile free hydrogen atoms and a functionality which can be a source of the energy holes. The energy reactor includes one of an electrolytic cell, a pressurized hydrogen gas cell, and a hydrogen gas discharge cell.

25 A preferred pressurized hydrogen gas energy reactor comprises a vessel; a source of hydrogen; a means to control the pressure and flow of hydrogen into the vessel; a material to dissociate the molecular hydrogen into atomic hydrogen, and a material which can be a source of energy holes in the gas phase. The gaseous source of energy holes includes those that sublime, boil, and/or are volatile at the elevated operating temperature of the gas energy reactor wherein the shrinkage reaction occurs in the gas phase.

35 The present invention further comprises methods and apparatuses for repeating a shrinkage reaction according to the present invention to cause energy release and to provide shrunken atoms and molecules with novel properties such as

CLAIMS

1. A cell for extracting energy from hydrogen atoms comprising:
a reaction vessel containing gaseous hydrogen atoms and a gaseous catalyst having a net enthalpy of reaction of about $27 * (p/2)$ eV, where p is an integer greater than 1, whereby said hydrogen atoms react with said catalyst in said vessel at a pressure less than atmospheric, thereby releasing energy and producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.
2. A cell according to claim 1, wherein said gaseous catalyst is adapted to sublime, boil, or volatilize when heated.
3. A cell according to claim 1 or claim 2, wherein said gaseous catalyst is formed from a salt of rubidium or potassium.
4. A cell according to claim 3, wherein said salt of potassium is KF, KCl, KBr, KI, K_2S_2 , KOH, K_2SO_4 , K_2CO_3 , K_2PO_4 , and K_2GeF_4 .
5. A cell according to claim 1 or claim 2, wherein said gaseous catalyst comprises a cation having a vapor pressure greater than zero when said gaseous catalyst is heated, said cation being (K^+) , (Rb^+) , (Mo^{2+}) , or (Ti^{2+}) .

6. A cell according to claim 1 or claim 2, wherein said gaseous catalyst comprises a pair of cations having a vapor pressure greater than zero when said gaseous catalyst is heated, said pair of cations being: $(\text{Sn}^{4+}, \text{Si}^{4+})$, $(\text{Pr}^{3+}, \text{Ca}^{2+})$, $(\text{Sr}^{2+}, \text{Cr}^{2+})$, $(\text{Cr}^{3+}, \text{Tb}^{3+})$, $(\text{Sb}^{3+}, \text{Co}^{2+})$, $(\text{Bi}^{3+}, \text{Ni}^{2+})$, $(\text{Pd}^{2+}, \text{In}^+)$, $(\text{La}^{3+}, \text{Dy}^{3+})$, $(\text{La}^{3+}, \text{Ho}^{3+})$, (K^+, K^+) , $(\text{V}^{3+}, \text{Pd}^{2+})$, $(\text{Lu}^{3+}, \text{Zn}^{2+})$, $(\text{As}^{3+}, \text{Ho}^{3+})$, $(\text{Mo}^{5+}, \text{Sn}^{4+})$, $(\text{Sb}^{3+}, \text{Cd}^{2+})$, $(\text{Ag}^{2+}, \text{Ag}^+)$, $(\text{La}^{3+}, \text{Er}^{3+})$, $(\text{V}^{4+}, \text{B}^{3+})$, $(\text{Fe}^{3+}, \text{Ti}^{3+})$, $(\text{Co}^{2+}, \text{Ti}^+)$, $(\text{Bi}^{3+}, \text{Zn}^{2+})$, $(\text{As}^{3+}, \text{Dy}^{3+})$, $(\text{Ho}^{3+}, \text{Mg}^{2+})$, $(\text{K}^+, \text{Rb}^+)$, $(\text{Cr}^{3+}, \text{Pr}^{3+})$, $(\text{Sr}^{2+}, \text{Fe}^{2+})$, $(\text{Ni}^{2+}, \text{Cu}^+)$, $(\text{Sr}^{2+}, \text{Mo}^{2+})$, $(\text{Y}^{3+}, \text{Zr}^{4+})$, $(\text{Cd}^{2+}, \text{Ba}^{2+})$, $(\text{Ho}^{3+}, \text{Pb}^{2+})$, $(\text{Pd}^{2+}, \text{Li}^+)$, $(\text{Eu}^{3+}, \text{Mg}^{2+})$, $(\text{Er}^{3+}, \text{Mg}^{2+})$, $(\text{Bi}^{4+}, \text{Al}^{3+})$, $(\text{Ca}^{2+}, \text{Sm}^{3+})$, $(\text{V}^{3+}, \text{La}^{3+})$, $(\text{Gd}^{3+}, \text{Cr}^{2+})$, $(\text{Mn}^{2+}, \text{Ti}^+)$, $(\text{Yb}^{3+}, \text{Fe}^{2+})$, $(\text{Ni}^{2+}, \text{Ag}^+)$, $(\text{Zn}^{2+}, \text{Yb}^{2+})$, $(\text{Se}^{4+}, \text{Sn}^{4+})$, $(\text{Sb}^{3+}, \text{Bi}^{2+})$, and $(\text{Eu}^{3+}, \text{Pb}^{2+})$.

7. A cell according to claim 1, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about $E_b = 13.6/n^2 \text{ eV}$, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

8. A cell according to any one of claims 1 to 7, wherein said cell maintains the reaction,

$$m \times 27.21 \text{ eV} + \text{H} \left[\frac{a_H}{m'} \right] + \text{H} \left[\frac{a_H}{p} \right] \rightarrow \text{H}^+ + e^- + \text{H} \left[\frac{a_H}{(p+m)} \right] + [(p+m)^2 - p^2 - (m^2 - 2m)] \times 13.$$

$$\text{H}^+ + e^- \rightarrow \text{H} \left[\frac{a_H}{1} \right] + 13.6 \text{ eV}$$

$$\text{H} \left[\frac{a_H}{m'} \right] + \text{H} \left[\frac{a_H}{p} \right] \rightarrow \text{H} \left[\frac{a_H}{1} \right] + \text{H} \left[\frac{a_H}{(p+m)} \right] + [2pm + m^2 - m^2] \times 13.6 \text{ eV} + 13.6 \text{ eV}$$

where m and p are positive non-zero integers, m is an integer greater than 1, and a_H is the Bohr radius.

9. A cell according to any one of claims 1 to 8, whereby said gaseous hydrogen atoms are formed in the cell by reacting molecules containing hydrogen atoms, and a second catalyst for disassociating said molecules to produce hydrogen atoms.

10. A cell according to any one of claims 1 to 9, whereby said vessel maintains a hydrogen partial pressure of less than about one torr.

11. A cell according to any one of claims 1 to 10, wherein said vessel maintains a catalyst partial pressure of between about 50 and 250 millitorr.

12. A cell according to any one of claims 1 to 11, wherein said vessel further contains a non-reactive gas, such that the rate of reaction of said gaseous hydrogen atoms with said gaseous catalyst is controlled by regulating the amount of said non-reactive gas in said vessel.

13. A cell according to any one of claims 1 to 12, further comprising a valve for selectively releasing said catalyst from said vessel.

14. A cell according to any one of claims 1 to 13, further comprising a valve for selectively releasing said hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

15. A cell according to any one of claims 1 to 14, wherein the vapor partial pressure of said gaseous catalyst varies with temperature.

16. A cell according to any one of claims 1 to 15, further comprising a heater for heating said vessel.

17. A cell according to any one of claims 1 to 16, further comprising a catalyst reservoir communicating with said reaction vessel, said reservoir containing said gaseous catalyst or a source thereof.

18. A cell according to claim 17, further comprising a heater for heating said catalyst.

19. A cell according to claim 17 or claim 18, wherein said reservoir is external to said reaction vessel.

20. A cell according to claim 19, further comprising a flow control valve for controlling the flow of said catalyst from said reservoir into said vessel.

21. A cell according to any one of claims 1 to 20, further comprising a chamber for containing hydrogen atoms or a source of hydrogen atoms communicating with said reaction vessel.

22. A cell according to claim 21, further comprising a flow control valve for controlling the flow of hydrogen atoms from said chamber into said vessel.

23. A cell according to claim 21 or claim 22, wherein said source of hydrogen atoms comprises an internal combustion engine.

24. A cell according to claim 21 or claim 22, wherein said source of hydrogen atoms comprises a gas turbine.

25. A cell for extracting energy from hydrogen atoms, substantially as hereinbefore described with reference to any one of the examples.

26. A method for extracting energy from hydrogen comprising the steps of: providing a gaseous catalyst having a net enthalpy of reaction of about $27 * (p/2)$ eV, where p is an integer greater than 1; providing gaseous hydrogen atoms; and reacting said gaseous catalyst with said gaseous hydrogen atoms, thereby producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1, said reaction occurring at a pressure less than atmospheric pressure.

27. A method according to claim 26, wherein said gaseous hydrogen atoms are provided by disassociating molecules containing hydrogen atoms.

28. A method according to claim 26, wherein gaseous hydrogen atoms are provided by contacting molecules containing hydrogen atoms with a catalyst for disassociating said molecules to produce hydrogen atoms in the gas phase.

29. A method according to any one of claims 26 to 28, wherein said gaseous catalyst comprises gaseous hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

30. A method according to any one of claims 26 to 29, wherein said gaseous catalyst is provided according to the reaction,

$$m \times 27.21 \text{ eV} + \text{H} \left[\frac{a_H}{m'} \right] + \text{H} \left[\frac{a_H}{p} \right] \rightarrow \text{H}^+ + e^- + \text{H} \left[\frac{a_H}{(p+m)} \right] + [(p+m)^2 - p^2 - (m'^2 - 2m)] \times 13.$$

$$\text{H}^+ + e^- \rightarrow \text{H} \left[\frac{a_H}{1} \right] + 13.6 \text{ eV}$$

$$\text{H} \left[\frac{a_H}{m'} \right] + \text{H} \left[\frac{a_H}{p} \right] \rightarrow \text{H} \left[\frac{a_H}{1} \right] + \text{H} \left[\frac{a_H}{(p+m)} \right] + [2pm + m^2 - m'^2] \times 13.6 \text{ eV} + 13.6 \text{ eV}$$

where m and p are integers greater than zero, m' is an integer greater than 1, and a_H is the Bohr radius.

31. A method according to any one of claims 26 to 30, wherein said reaction occurs at a pressure less than about one torr.

32. A method according to any one of claims 26 to 31, wherein the partial pressure of gaseous hydrogen atoms in the reaction is less than about one torr.

33. A method according to any one of claims 26 to 31, wherein the partial pressure of the gaseous catalyst in the reaction is between about 50 and 250 millitorr.
34. A method according to any one of claims 26 to 33, wherein the vapor partial pressure of said gaseous catalyst is controlled by varying the temperature of said gaseous catalyst.
35. A method for extracting energy from hydrogen, substantially as hereinbefore described with reference to any one of the examples.
36. Energy extracted from hydrogen by the method of any one of claims 26 to 35.