Claims

1. A hydrogen producing apparatus comprising an enclosed volume, the volume comprising:
- at least one gas inlet **(1)** from the outside environment;
- at least one porous matrix material **(2)** with hygroscopic or deliquescent properties for capturing water from a gas containing water to provide liquid water within pores of the porous matrix material **(2)**, and having ionic conductivity, the pores having a diameter of at least 10 nm, and optionally at least one separator **(7)**;
- an oxygen producing electrode **(3)** and a hydrogen producing electrode **(4)**, positioned on opposite sides of said porous matrix material **(2)** or on opposite sides of said separator **(7)**, thereby forming an assembly;
- a connection for connecting the electrodes to a power source **(5)**; and
- at least one outlet for the produced hydrogen **(6)**.

2. The apparatus according to claim 1, wherein the porous matrix material **(2)** is positioned between an oxygen producing electrode **(3)** and a hydrogen producing electrode **(4)**.

3. The apparatus according to claim 1 or 2, wherein a gas- impermeable separator **(7)** is absent in the enclosed volume.

4. The apparatus according to claim 3, wherein in addition a further porous matrix material **(2)** is positioned at one or both outer sides of the assembly.

5. The apparatus according to claim 1, wherein a gas-impermeable separator **(7)** is positioned between an oxygen producing electrode **(3)** and a hydrogen producing electrode **(4)**, and wherein a porous matrix material is positioned at one or both outer sides of the assembly.

6. The apparatus according to claim 5, wherein a gas-impermeable separator **(7)** is positioned between an oxygen producing electrode **(3)** and a hydrogen producing electrode **(4)**, and wherein a porous matrix material is positioned between the separator and the oxygen producing electrode

(3) and/or between the separator and the hydrogen producing electrode **(4)**.

7. The apparatus according to claim 5 wherein in addition a further porous matrix material **(2)** is positioned at one or both outer sides of the assembly.

8. The apparatus according to any one of claims 1, 2 and 5 to 7, wherein the separator is a gas-impermeable separator that is a membrane.

9. The apparatus according to any one of claims 1 to 8, whereby the porous matrix material comprises one or more solutes providing hygroscopic, deliquescent and/or conductive properties.

10. The apparatus according to any one of claims 1 to 6 whereby the gas producing electrodes are connected directly to a device for solar energy conversion, such as a photovoltaic or photoelectrochemical device.

11. The apparatus according to any one of claims 1 to 10, whereby the porous matrix material has a thickness from at least 300 µm.

12. The apparatus according to any one of claims 1 to 11, whereby the porous matrix material contains a hydrophilic polymer and the solute provides an ionic conductivity of at least 0.1 Siemens/m.

13. A method of producing hydrogen in an apparatus according to any one of claims 1 to 12, the method comprising the steps of:
-allowing the entrance of an inlet gas comprising water via the gas entry, thereby regenerating the water content of the porous matrix material;
-optionally closing the gas entry after regeneration of the porous matrix-material;
and allowing conversion of electrical energy and water molecules into hydrogen and oxygen molecules on the cathode and anode, respectively.

14. The method according to claim 13, wherein the gas entry is opened and closed by a light-sensitive sensor according to the diurnal cycle or by a humidity-dependent sensor.