~~**PCT/EP2021/077315**~~

~~**Reply second Written Opinion.**~~

~~**Amended Claims (clean copy)**~~

Claims

1. ~~An apparatus, producing hydrogen from humid ambient air,~~ 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 and having ionic conductivity, 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 ~~positioned~~ 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 **(6)** for the produced hydrogen**.**

2. The apparatus according to claim 1, ~~comprising a separator, wherein a~~ wherein the porous matrix material **(2)** is ~~in contact with the~~ 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, whereby the gas-impermeable separator 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.

~~3~~10. The apparatus according to ~~claim 1 or 2~~any one of claims 1 to 6, whereby the gas producing electrodes ~~**(3)** and **(4)**~~ are connected directly to a device for solar energy conversion, such as a photovoltaic or photoelectrochemical device.

~~4. The apparatus according to claim 1, 2 or 3, wherein said least one porous matrix material **(2)** has deliquescent properties.~~

~~5. The apparatus according to claim 1, 3 or 4, wherein the separator **(7)** is absent and~~
~~- a porous matrix material **(2)** is positioned between the at least one gas inlet **(1)** and the oxygen producing electrode **(3)**~~
~~and/or~~
~~-a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the hydrogen producing electrode **(4)**.~~

~~6. The apparatus according to claim 5, wherein~~
~~-a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the hydrogen producing electrode **(4)** and~~
~~-a porous matrix material **(2)** is positioned between the at least one gas inlet **(1)** and the oxygen producing electrode **(3)**.~~

~~7. The apparatus according to claim 5 or 6, wherein a further porous matrix material **(2)** is positioned between the hydrogen producing electrode **(4)** and the at least one outlet **(6).**~~

~~8. The apparatus according to claim 5 or 6, wherein~~

~~- a porous matrix material **(2)** is absent between the at least one gas inlet **(1)** and the oxygen producing electrode **(3)** and~~

~~- a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the hydrogen producing electrode **(4)** and~~

~~- a porous matrix material **(2)** is absent between the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~9. The apparatus according to any one of claims 5 to 7, wherein~~

~~- a porous matrix material is positioned between the at least one gas inlet **(1)** and the oxygen producing electrode **(3)** and~~

~~- a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the hydrogen producing electrode **(4)**, and~~

~~- a further porous matrix material is positioned between the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~10. The apparatus according to any one of claims 1 to 4, wherein a gas-impermeable separator **(7)** is present between the oxygen producing electrode **(3)** and the hydrogen producing electrode **(4)**, and wherein~~

~~a porous matrix material **(2)** is positioned between the at least one inlet **(1)** an the oxygen producing electrode **(3)**~~

~~and/or~~

~~- a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the separator **(7)**.~~

~~11. The apparatus according to claim 10, wherein~~

~~- a further porous matrix material is positioned between the separator **(7)** and the hydrogen producing electrode **(4)**~~

~~and/or~~

~~- a further porous matrix material is positioned the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~12. The apparatus according to claim 10 or 11, wherein~~

~~- a porous matrix material **(2)** is positioned between the at least one inlet **(1)** an the oxygen producing electrode **(3)**~~

~~- a porous matrix material **(2)** is absent between the oxygen producing electrode~~

~~**(3)** and the separator **(7)**~~

~~- a porous matrix material **(2)** is absent between the separator **(7)** and the hydrogen producing electrode **(4)** and,~~

~~- a further porous matrix material is positioned the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~13. The apparatus according to claim 10 or 11, wherein~~

~~- a porous matrix material **(2)** is absent between the at least one inlet **(1)** an the oxygen producing electrode **(3),**~~

~~- a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the separator **(7),**~~

~~- a porous matrix material is positioned between the separator **(7)** and the hydrogen producing electrode **(4)** and,~~

~~- a porous matrix material **(2)** is absent between the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~14. The apparatus according to claim 10 or 11, wherein~~

~~- a porous matrix material **(2)** is absent between the at least one inlet **(1)** an the oxygen producing electrode **(3),**~~

~~- a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the separator **(7),**~~

~~- a porous matrix material **(2)** is absent between the separator **(7)** and the hydrogen producing electrode **(4)** and,~~

~~- a porous matrix material **(2)** is absent the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~15. The apparatus according to claim 10, wherein~~

~~- a porous matrix material **(2)** is positioned between the at least one inlet **(1)** an the oxygen producing electrode **(3),**~~

~~- a porous matrix material **(2)** is absent between the oxygen producing electrode **(3)** and the separator **(7),**~~

~~- a porous matrix material **(2)** is absent between the separator **(7)** and the hydrogen producing electrode **(4)** and,~~

~~- a porous matrix material **(2)** is absent between the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~16. The apparatus according to claim 10 or 11, wherein~~
~~- a porous matrix material **(2)** is positioned between the at least one inlet **(1)** an the oxygen producing electrode **(3)** and~~
~~- a porous matrix material **(2)** is positioned between the oxygen producing electrode **(3)** and the separator **(7)**~~
~~- a porous matrix material is positioned between the separator **(7)** and the hydrogen producing electrode **(4)** and~~
~~- a porous matrix material is positioned the hydrogen producing electrode **(4)** and the at least one outlet **(6)**.~~

~~17. The apparatus according to any one of claims 1 to 4 and 9 to 15, wherein the gas-impermeable separator **(7)** is a membrane.~~

~~18. The apparatus according to any one of claims 1 to 17, whereby the porous matrix material **(2)** comprises one or more solutes providing hygroscopic, deliquescent and/or conductive properties.~~

~~19~~11. The apparatus according to any one of claims 1 to ~~18~~10, whereby the porous matrix material ~~**(2)**~~ contains pores having a diameter of at least 10 nm.

~~20~~12. The apparatus according to any one of claims 1 to ~~19~~11, whereby the porous matrix material ~~**(2)**~~ has a thickness from at least 300 µm.

~~21~~13. The apparatus according to any one of claims ~~10~~1 to ~~20~~12, whereby the porous matrix material ~~**(2)**~~ contains a hydrophilic polymer and the solute provides an ionic conductivity of at least 0.1 Siemens/m.

~~22~~14. A method of producing hydrogen in an apparatus according to any one of claims 1 to ~~21~~13, the method comprising the steps of:
-allowing the entrance of ~~humid ambient air via the at least one gas inlet **(1)**~~ an inlet gas comprising water via the gas entry, thereby regenerating the water content of the porous matrix material ~~**(2)**~~;
-optionally closing the ~~at least one gas inlet **(1)**~~ gas entry after regeneration of the porous matrix material ~~**(2)**~~;
and allowing conversion of electrical energy and water molecules into hydrogen and oxygen molecules on the cathode ~~**(4)**~~ and anode ~~**(3)**~~, respectively.

~~23. The method according to claim 22 wherein the electrical energy is provided by connecting the gas producing electrodes **(3)** and **(4)** are directly to a device for solar energy conversion, such as a photovoltaic or photoelectrochemical device.~~

~~24. The method according to claim 22 or 23, further comprising the step of collecting the hydrogen being producing in the apparatus via the at least one outlet **(6)**.~~

~~25~~15. The method according to ~~any one of claims 22 to 24~~ claim 14, wherein the gas entry is opened and closed by a light-sensitive sensor according to the diurnal cycle or by a humidity-dependent sensor.