

CLAIMS:

1. A device for the electrolytic production of hydrogen and oxygen from a water-containing liquid, the device comprising:
 - an anodic half-cell which includes an anodic electrode, and
 - a cathodic half-cell which includes a cathodic electrode,
 - an anion exchange membrane (AEM) situated between the two half-cells, wherein:
 - the anodic electrode, the cathodic electrode, and the anion exchange membrane form an MEA,
 - means for feeding the water-containing liquid to only one of the anodic half-cell and the cathodic half-cell are provided, wherein:
 - at least the electrode in the other, substantially dry, half-cell is ionomer-free and/or binder-free.
2. A device as claimed in claim 1 wherein during use the water-containing liquid has a pH of 7 or higher.
3. A device as claimed in claim 1 wherein during use the water-containing liquid has a pH between 12 and 14.
4. A device as claimed in any preceding claim wherein the water containing liquid also comprises between 0.1% and 10% KOH.
5. A device as claimed in claim 1 wherein the temperature of the system is in the range of 40°C to 80 °C.
6. A device as claimed in any one of the preceding claims wherein the electrodes are connected to a power supply which is a source of renewable energy.
7. A device as claimed in any one of the preceding claims wherein the MEA is stabilised by one or more of:

- crosslinking of the polymeric backbone, spacer or ion-exchange groups of the membrane,
 - improving the intermolecular binding forces between the polymer and the catalyst,
 - a thicker membrane, or
 - a combination of any of the above.
8. A device as claimed in any one of the preceding claims wherein the device is adapted to produce hydrogen at elevated pressures above 1 bar.
9. A device as claimed in any one of the preceding claims wherein any of the anodic, or cathodic electrodes is:
- A catalyst coated membrane,
 - A catalyst coated substrate, or
 - A direct membrane deposition.
10. A device as claimed in claim 9 wherein the catalyst coated substrate may be any one of:
- Carbon based cloth
 - Carbon based paper
 - Carbon based felt
 - Stainless steel foam, and
 - Nickel based foam.
11. A device as claimed in any one of the preceding claims wherein at least one catalyst is made of platinum group free metals.
12. A device as claimed in any one of the preceding claims wherein a catalyst at the anode, for oxygen evolution reaction, includes non-stoichiometric transition metal oxides.
13. A device as claimed in any one of the preceding claims wherein a catalyst at the cathode, for hydrogen evolution reaction, includes: chalcogenides, pnictogenides, transition metal sulphides, transition metal phosphides, transition metals dispersed in

an electrically conductive substrate, or other non-stoichiometric transition metal oxides having spinel or perovskitic structures or transition metal complexes.

14. A device as claimed in any one of the preceding claims wherein the AEM is formed of a polymer backbone coupled with a functional group suitable for transporting anions, the polymer being any one of: polystyrene, polysulfone, polybenzimidazole, polyphenylene oxide, styrene-butadiene block copolymer, polyethylene.
15. A device as claimed in claim 14 wherein there is a spacer between the polymer backbone and functional group.
16. A device as claimed in any one of the preceding claims wherein the functional group can be any one or more of: ammonium, sulfonium or phosphonium salts