(12) UK Patent Application (19) GB (11) 2 113 904 A

(21) Application No **8134427**
(22) Date of filing **16 Nov 1981**
(43) Application published **10 Aug 1983**
(51) **INT CL**^{3} **H01M 6/18**
(52) Domestic classification **H1B** 460 614 614A 616 618
(56) Documents cited **None**
(58) Field of search **H1B**
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(54) Solid-state electrochemical devices

(57) Electrochemical devices suitable for room temperature, low current density applications are made from a combination of an electrode which is an active light metal, in particular magnesium, and a solid electrolyte of the form

$$M_n(R_1R_2R_4R_5N)I_{n+1}$$

or

$$M_n(R_1R_2R_3N(CH_2)_mNR_4R_5R_6)I_{n+2};$$

where R_1, R_2, R_3, R_4, R_5, R_6 can be straight or branched chains containing, or not containing, heteroatoms, or where R_1 and R_2 and/or R_4 and R_5 are opposite ends of a chain or branched chain or branched chain containing, or not containing, heteroatoms, in which case a cyclic structure embodying N is produced; m is 2, 3 etc.; preferred values of n are in the range 0 to 40; M is Cu (copper) or Ag (silver).

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SPECIFICATION

Solid-state electrochemical devices

This invention relates to solid-state electrochemical devices such as electrochemical cells, batteries, coulometers, and elapsed-time measuring devices.

According to the present invention, a solid state electrochemical device includes an electrolyte comprising an organic ammonium or polymethonium iodide, and an anode of an active metal, in particular a polyvalent metal.

More specifically, the device comprises a magnesium anode, and a solid electrolyte which consists of an organic ammonium or polymethonium iodide of the form

$$M_n(R_1R_2R_4R_5N)I_{n-1}$$

or

$$M_n(R_1R_2R_3N(CH_2)_mN\ R_4R_5R_6)I_{n+2};$$

where R_1, R_2, R_3, R_4, R_5, R_6 can be straight or branched chains containing or not containing heteroatoms, or where R_1 and R_2 and/or R_4 and R_5 are opposite ends of a chain or branched chain containing or not containing heteroatoms, in which case a cyclic structure embodying N is produced; m is 2, 3 etc.; preferred values of n are in the range 0 to 40; M is Cu (copper) or Ag (silver).

A typical device was prepared as follows:

An electrolyte was prepared by adding powdered silver iodide (6.389 g) to tetra ethyl amonium iodide (1 g). The materials were ground together in an agate pestle and mortar, and heated to 30°C below the melting point of the organic salt for 72 hours.

A test cell utilizing such an electrolyte was made in the following way. A layer of anode material, composed of fine magnesium powder mixed with powdered electrolyte material, was put into the base of a die chamber at room temperature and lightly compacted. A layer of the electrolyte material was then placed above the anode layer in the die chamber and lightly compacted. A layer of suitable cathode material was placed above the electrolyte layer and the resulting pellet was pressed at 3.5 $Mgcm^{-2}$ for a suitable period. The pellet formed the test cell and was suitably mounted so that voltage readings could be taken.

Suitable cathodes include iodine, iodine-containing complexes, e.g. perylene-iodine complexes, and manganese dioxide.

Cells prepared in this manner have produced open circuit voltages in excess of 1.3 volts. When cells have been tested under load, voltages greater than 0.7 volts have been maintained while a current of over 60μA was being drawn.

The use of magnesium as an anode in conjunction with the specified electrolytes provides unexpectedly useful devices and in particular, high voltages can be produced.

Claims (Filed on 16/11/82)

1. A solid-state electrochemical device which includes an electrolyte comprising an organic ammonium or polymethonium iodide, and an anode of an active metal.

2. A device as claimed in claim 1 in which the anode metal is magnesium.

3. A solid-state electrochemical device which comprises a magnesium anode, and a solid electrolyte which consists of an organic ammonium or polymethonium iodide of the form

$$M_n(R_1R_2R_4R_5N)I_{n+1}$$

or

$$M_n(R_1R_2R_3N(CH_2)_mN\ R_4R_5R_6)I_{n+2};$$

where R_1, R_2, R_3, R_4, R_5, R_6 can be straight or branched chains containing or not containing heteroatoms, or where R_1 and R_2 and/or R_4 and R_5 are opposite ends of a chain or branched chain containing or not containing heteroatoms, in which case a cyclic structure embodying N is produced; m is 2 or a larger integer; n is in the range 0 to 40; and M is copper or silver.

4. A device as claimed in claim 1, 2 or 3 comprising an electrochemical cell.

5. A device as claimed in claim 4 having an anode comprising anode metal powder mixed with powdered electrolyte.

6. A device as claimed in any preceding claim including a cathode containing iodine or an iodine-containing complex.

7. A device as claimed in any preceding claim including a cathode containing a transition metal oxide.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained