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Liquid Reactant Fuel Cell System for Underwater Use*

A first prototype of a pressure resistant fuel cell with liquid fuel and liquid oxidant (LRFC) for underwater use was developed in a common development project. This development was realized by the private-owned companies AMT GmbH (MEAs, stack), Enitech GmbH (electronics, housing), Seus GmbH & Co. KG (flow systems) and by the institutes Leibniz-Institut für Katalyse e.V. (catalysts) and INP Greifswald (pre-treatment of catalysts).

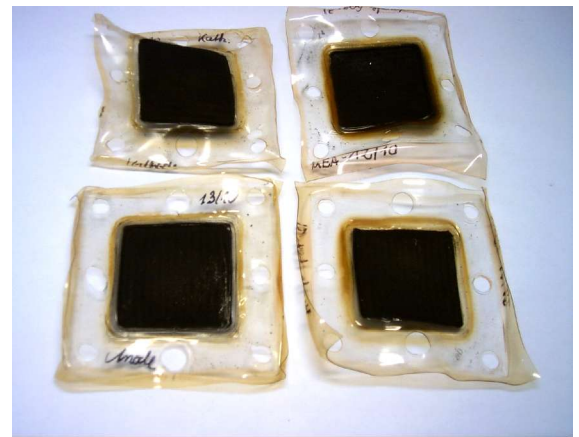
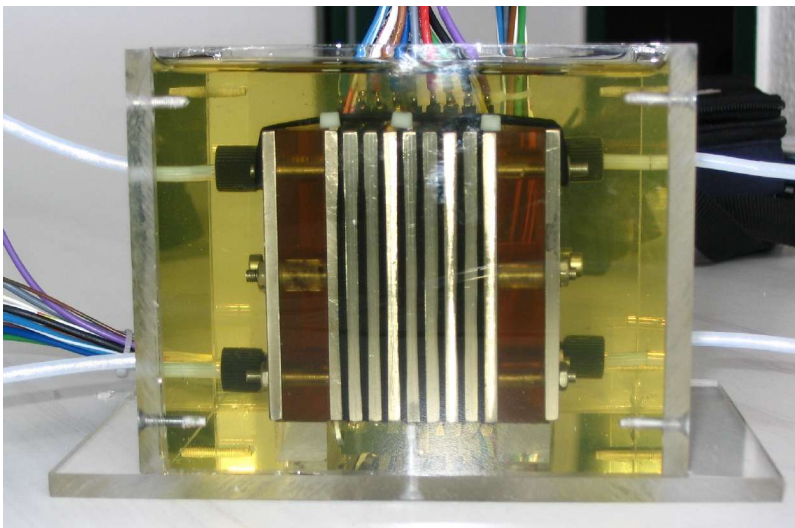
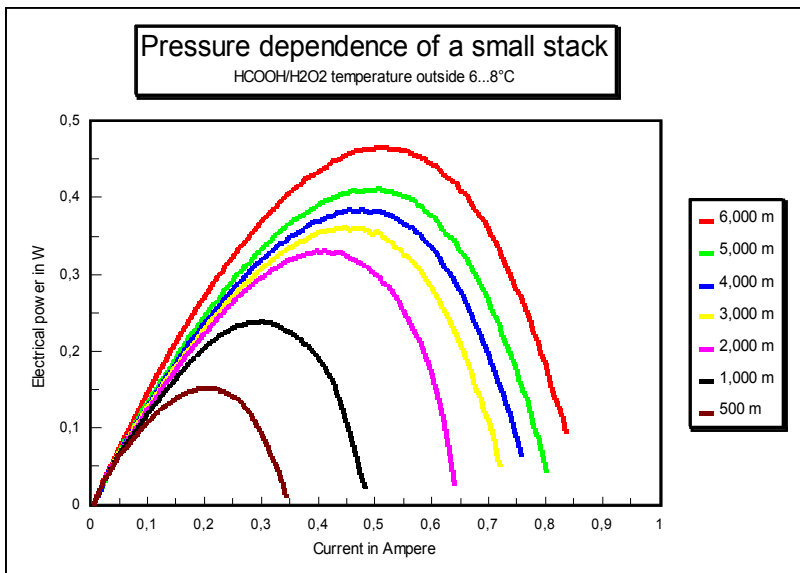


Fig.1: left: covered 8-cell stack, right: Membrane-Electrode-Assemblies (MEAs)

The general aim was to develop an innovative, long-time stable and pressure resistant fuel cell system as energy source for different purposes under water at low temperatures (probe systems, AUVs, ROVs, unmanned vehicles). The fuel cell prototype for testing all the special conditions and the performance contains a stack with 8 small cells, flexible tanks, low energy consuming pumps and operates with the liquid fuel formic acid and with hydrogen peroxide as oxidant. New materials have been developed for the stack materials and for the catalysts of both MEA sides.

Main advantages of the Liquid Reactant Fuel Cell (LRFC):

- ☞ more reliable and safer system compared with H_2/O_2 PEM fuel cells
- ☞ innovative catalysts for MEAs with less noble-metal content
- ☞ no pressure compensation necessary in deep sea, pressure-neutral design
- ☞ expensive equipment for pressure tanks (oxygen, hydrogen) not necessary
- ☞ lower weight and technically more simple than H_2/O_2 PEM fuel cells



The figure on the left side shows the results of the pressure test in the pressure vessel using a pressure-neutral 3 cell stack. It was shown, that the electrical power at a depth of 6.000 m (600 bar) increases strongly. Compared with the conditions under air pressure (1013 mbar) the maximum power in the deep sea is 3 times higher.

Fig.2: Pressure dependence of the stack.

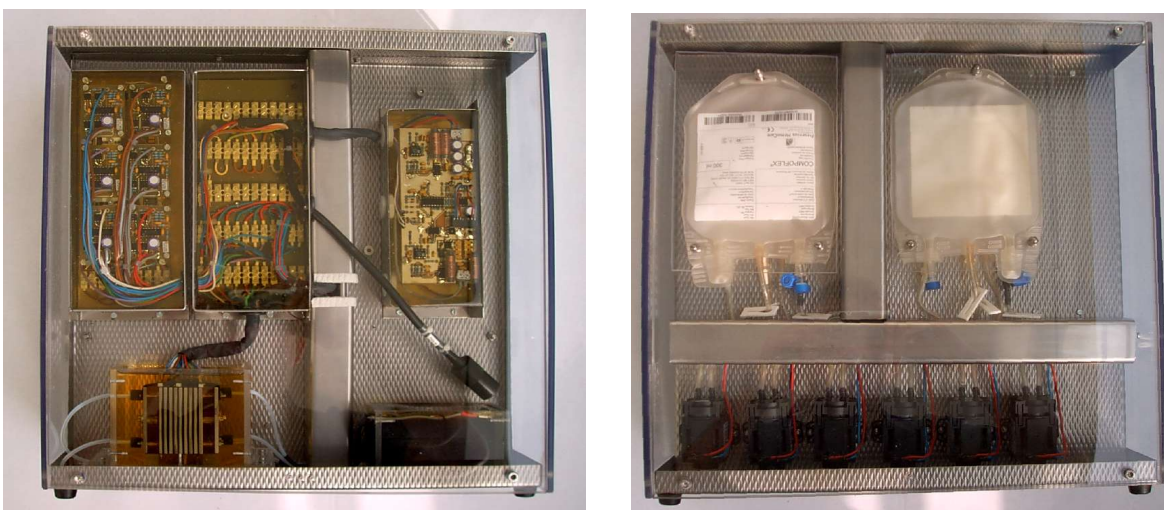


Fig. 3: Complete Fuel Cell System with fornz view (left) and back view (right).

Temporary technical data of the prototype:

- ☞ Fuel: formic acid, oxidant: hydrogen peroxide
- ☞ Catalysts: pre-treated organo-metallic/carbon and noble metal/carbon mixtures
- ☞ Pressure range: 0...6.000 dbar
- ☞ All parts pressure-neutral covered with flexible materials
- ☞ Temperature range: 2...70°C
- ☞ Power: up to 75 mW/cm² with low loadings
- ☞ Total power range on customers demand
- ☞ Dimensions of the system flexible

*Claimed Patents:

DE 103 24 200 A1, DE 103 24 201 A1, DE 10 2005 015 572 A1, DE 10 2005 033 938 A1

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Supported by the German BMWA (PRO INNO), KF 0455002KFK3

A common development of the partners:

AMT Analysenmesstechnik GmbH – Enitech GmbH – INP Greifswald -
Leibniz-Institut für Katalyse e.V. – Seus GmbH & Co. KG

In view of our policy of continual improvement and further development, the design and specifications of our products may vary from those illustrated in this brochure.