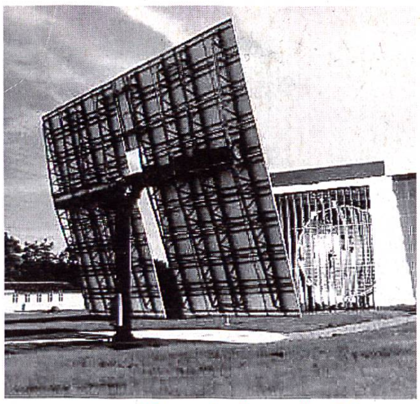
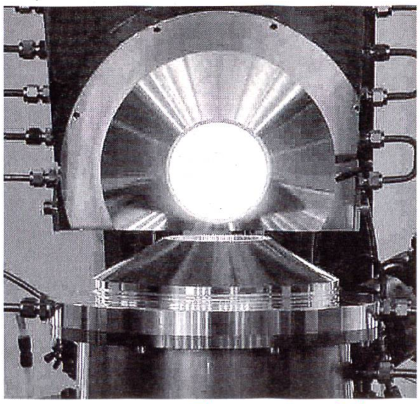
HYDROGEN

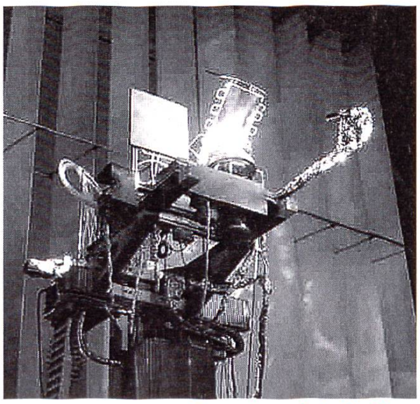
Solar sandwich



The solar "oven" at the Paul Scherrer Institute in Villigen



The opening of the solar reactor after an experiment



Experiment rig in the solar oven

Swiss research groups in the vanguard of developments in hydrogen electrolysis

Hydrogen is generally regarded as the most promising substitute for fossil fuels. But future large-scale use of hydrogen as a fuel will only be feasible if it can be produced on a sustainable basis. Swiss research is pursuing two alternative approaches to hydrogen generation using solar energy.

Tandem cell. Researchers at the Federal Institute of Technology in Lausanne (EPFL) and the University of Geneva have collaborated to develop a solar cell that produces hydrogen. "Our technology promises higher efficiency and lower cost than the conventional 'brute force' method in which solar electricity drives an electrolysis unit," declares Michael Grätzel, Head of the Laboratory for Photonics and Interfaces at the EPFL.

The new solar cell consists of a sandwich of two light-absorbing layers, hence the name "tandem cell". The upper part absorbs the blue component of sunlight, whose energy is used to oxidize water. In the first half of the reaction, oxygen ions are split off from the water.

In the other half, the remaining hydrogen ions are reduced to form hydrogen gas. The electricity needed is generated in the lower part of the sandwich. This consists in turn of a dye cell to absorb the red and green components of the sunlight.

Jan Augustynski and his team at the Institute of Chemistry at Geneva University have developed the vital component needed for the cell: a thin translucent film consisting of billions of minute particles (so-called nanocrystals) of the semiconductor material tungsten-oxide. The tungsten film forms the photo electrode absorbing the blue sunlight in the upper part.

The new tungsten film enables the production of tandem cells that store 5 to 6 percent of the incident sunlight in the form of hydrogen. This is a major advance compared to earlier technologies. The process is patented, and is to be developed in collaboration with an English company.

Moreover, to increase efficiency, new materials are being tried to accelerate the chemical processes taking place in the electrodes. Water, for example, can be electrolysed three-times more efficiently using a silver-chloride electrode in which gold particles of several nanometers diameter are dispersed – the crux of research by Antonio Currao and Gion Calzaferri at the Department of Chemistry and Biochemistry at Berne University.

Solar inferno. The Paul Scherrer Institute in Villigen (PSI) is pinning its hopes on the reaction between zinc and water vapour. The final products being simply hydrogen and zinc oxide. The zinc oxide can be converted back to metallic zinc in a solar crucible, and the cycle begun anew. As in the tandem cell, solar energy is again stored in the form of hydrogen, but in quite a different way.

To reduce the zinc oxide, mirrors direct sunlight onto the crucible to generate the temperature of 2000°C required. The "solar inferno" in the crucible makes heavy demands on the employed materials technology. Says Robert Palumbo, Head of the Laboratory for Solar Technology: "When carbon is injected into the zinc oxide, pure zinc is obtained at a much lower temperature of 1200°C. We are studying this variant at PSI within an international project." Though the process is no longer CO_2-free, the prospects of market maturity are much better in the middle term.

Eco Marathon hydrogen car

Last year, a hydrogen PAC (French abbreviation for "pile à combustible", or fuel cell) car took part for the first time in the Shell Eco Marathon at Nogaro in Southern France. The Federal Institute of Technology in Zurich developed the car in collaboration with the Paul Scherrer Institute and the University of Valencienne.

The car uses a fuel cell to convert hydrogen into electricity to power its electric motor. Although this ultra-light, single-seater vehicle carries only 15 grams of hydrogen in its metal hydride tank, it is enough to travel 90 km (equivalent to 1500 km on 1 litre of petrol). Eco Marathon's benchmark is to cover 25 km at an average speed equalling or exceeding 30 km/h with rock-bottom fuel consumption.

Impressum

energy extra
published every 2 months
edition 3/2004

BFE
OFEN
UFE
SFOE

Publisher
Swiss Federal Office of Energy (BFE), 3003 Berne, Switzerland

Editorial staff
Marianne Zünd, Mireille Fleury, Communication Section,
Telephone +41 31 322 5611, Fax +41 31 323 2510
www.energie-schweiz.ch
Email: *office@bfe.admin.ch*
Büro Cortesi, Biel, Switzerland, Tel +41 32 327 0911, Fax +41 32 327 0912
Email: *buerocortesi@bcbiel.ch*
Werner Hadorn (editor)
Texts: Hans-Ueli Aebi, Jean-Jacques Daetwyler, Fabio Gilardi, Werner Hadorn, BFE
Translation: Brian Backman, Bob Barton, James Morris
Photographs + illustrations: Fabio Gilardi, Olivier Messerli
Layout: Hans Eggimann