Int. J. Hydrogen Energy, Vol. 16, No. 8, pp. 577–578, 1991.
Printed in Great Britain.

0360–3199/91 $3.00 + 0.00
Pergamon Press plc.

SHORT COMMUNICATION

PROGRESS IN HYDROGEN DETECTION: A NEW PHOTOPYROELECTRIC DEVICE

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(*Received for publication* 17 *April* 1991)

Abstract—In this short communication we would like to draw the attention of the hydrogen scientific community to the development of a new and inexpensive hydrogen detector able to operate through a broad range of low temperatures (−190 to +53°C).

In recent years, hydrogen has grown to be one of the most useful gases. In fact, in many industries such as chemical, food, metallurgical, energy, electronic and others, hydrogen is increasingly taking the role of a raw material [1]. For this reason, among others, it has become very important to develop highly sensitive hydrogen detectors to prevent accidents due to H_2 gas leakage, thus saving lives and equipment. Such detectors

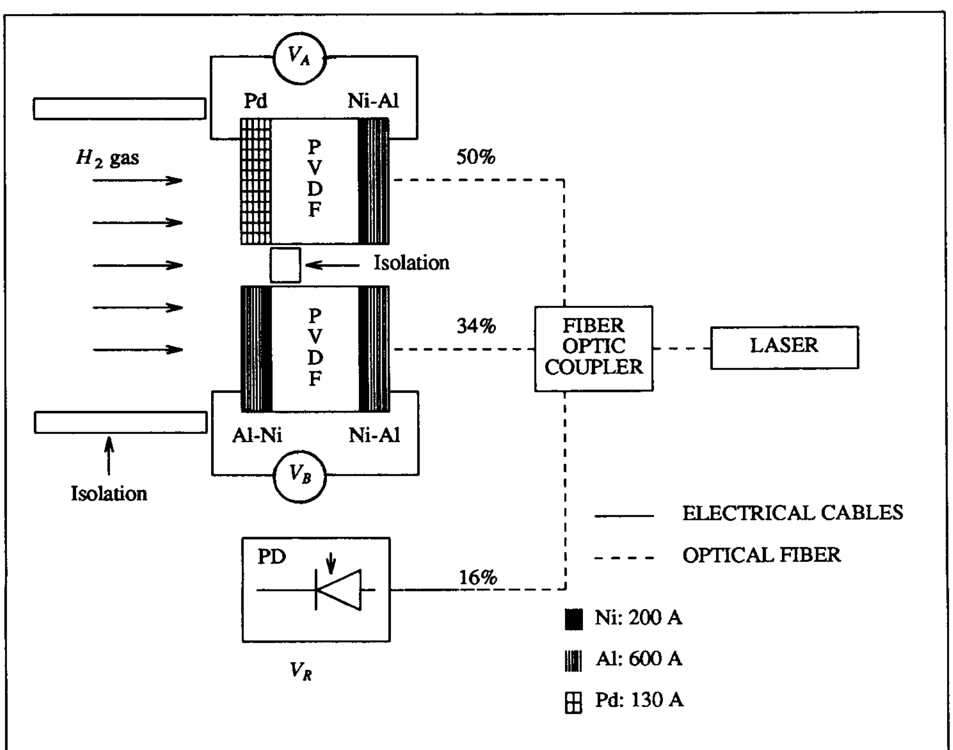

Fig. 1. Schematic of the hydrogen gas detection part of the photopyroelectric detector including the active Pd-coated and reference Al–Ni electrodes.

should allow continuous monitoring of the concentration of gases in the environment in a quantitative and selective way. In addition, this control system should be financially accessible to potential users, and functional under broad ranges of environmental conditions.

Beginning in the 1970s considerable effort has been expended toward the development of gas sensors and especially hydrogen detectors. Many of these detectors have been found to be problematic due to temperature fluctuations and especially due to the requirement of high temperature for their good operation and performance. In 1988 the development of a new photopyroelectric (PPE) Pd-PVDF (polyvinylidene fluoride) hydrogen detector was undertaken in our laboratory [2, 3] with the support of the ministry of Energy, Mines, and Resources of Canada. Initial results have been shown to be very promising toward the development of a new type of gas detection and analysis photothermal solid state device based on polymer–metal interface phenomena. The new photopyroelectric device not only seems to overcome many of the above problems related to the ambient temperature, but it also has an easy and inexpensive fabrication process. This device has attracted attention as a new trace hydrogen sensor [4, 5].

The operation of the photopyroelectric detector is very simple: an i.r. laser beam from an inexpensive semiconductor laser produces alternating temperature gradients, in PVDF, which result in alternating voltage due to the photopyroelectric effect [6]. Exposure to hydrogen gas produces an increased differential signal between the lead and the reference electrodes [2, 3] (see Fig. 1). The new H_2 detector has been found to be very sensitive, even for concentrations down to 40 ppm. The high detectivity, fast response, high selectivity, durability and reversibility at room temperature is an important advantage of our device *vis-à-vis* the well-known Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET) devices [7].

From the point of view of hydrogen adsorption/absorption kinetics, it has been found that at low concentrations the device operation is Langmuirian. The thickness of the palladium layer evaporated on the PVDF film plays an important role in determining sensitivity and durability of the hydrogen sensor.

Further experiments have demonstrated device sensitivity to hydrogen even at temperatures close to $-63°C$, much lower than conventional hydrogen sensors [8]. Recently the detector has been found to respond even at temperatures close to liquid nitrogen [9].

Acknowledgements—The support of the Ministry of Energy, Mines, and Resources Canada through a contract CHES is gratefully acknowledged.

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