Threshold sensor for high-doses of radiation

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***Abstract*—MEMS threshold sensor for high-doses of radiation (above 10 kGy) has been design and development. In the sensor, small portion of high density polyethylene (HDPE) is trapped inside silicon-glass MEMS hermetically sealed structure. When the sensor is exposed to ionizing radiation, HDPE degrades and releases atomic hydrogen. The resulting pressure of hydrogen destroys thin silicon membrane of the sensor. The proper parameters of the silicon membrane of the sensor have been selected by simulations in ANSYS software.**

***Keywords*— MEMS sensor, radiaition sensor, modeling of silicon membrane**

I. INTRODUCTION

High doses of radiation (>10 kGy) can be found in nuclear power plants, storage of spent nuclear fuel, nuclear waste disposal site as well as after nuclear accidents. High radiation doses are also observed in experimental infrastructures for example LHC where level of radiation is low but long term doses are high, above 10 kGy.

Measurement of high radiation doses may be estimated post factum by family of passive thermo- and photoluminescence indicators or hydrogen pressure dosimeters. In situ measurements have been up-to-day obtained only for low or medium doses by solid-state MOS based sensors.

MEMS sensor for measurements of high-doses of radiation, above 10 kGy has been shown. In the sensor, small portion of high density polyethylene (HDPE) is trapped inside silicon-glass MEMS hermetically sealed structure (Fig. 1a). When the sensor is exposed to ionizing radiation, HDPE degrades and releases atomic hydrogen proportional to radiation dose. This radiolysis phenomenon of polymers has been described in details in previous work [1]. The pressure inside the chamber increase and membrane of known mechanical properties is destroyed under the influence of the growing pressure corresponds to the absorbed radiation dose (Fig. 1b).

The sensors have been irradiated by highly energetic (6 MeV) electron beam with doses above 10 kGy (in National Centre for Nuclear Research, Otwock, Poland). Blow-up effects proportional to irradiation doses have been observed.

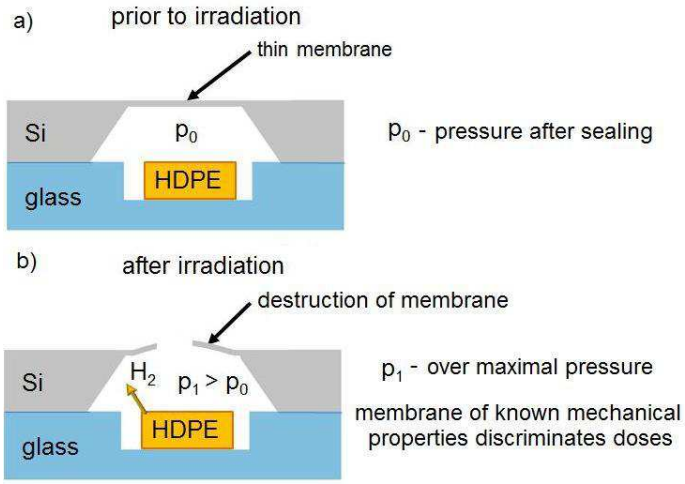

Fig. 1 Principle of operation: (a) sensor before irradiation; (b) sensor after irradiation

II. RESULTS

Blow-up parameters of several silicon membranes for set pressure have been selected by modeling in ANSYS simulation software. The first tests of the sensor in laboratory conditions have been made. More details and up-dated results of experiments will be shown in the full paper.

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