NEW GAS SENSING DEVICE TO THE HUNVEYOR-2 UNIVERSITY LANDER OF THE PÉCS UNIVERSITY, HUNGARY. ***S. Hegyi[1], B. Kovács[2], M. Keresztesi[1], L. Gimesi[1], A. Halász[1], Sz. Bérczi[3].*** [1] University of Pécs, Faculty of Science, Dept. Informatics and G. Technology, H-7624 Pécs, Ifjúság u. 6. Hungary (hegyis@ttk.pte.hu), [2]University of Pécs, Faculty of Science, Dept. Physical Chemistry, H-7624 Pécs, Ifjúság u. 6., Hungary, [3]Eötvös University, Fac. of Science, Dept. G. Physics, H-1117 Budapest, Pázmány P. s. 1/a. Hungary.

ABSTRACT
During the last 4 years various experiments were developed on the planetary lander Hunveyor-2 and they were successfully used in the planetary science education: construction, experiment planning, informatics and robotics. Our new optical sensor device was constructed for the sensing of ammonia, the life-building block unit on planetary surfaces such as Mars or Europa.

INTRODUCTION
On the Pécs University, (Dept. of Informatics and General Technology and Dept. of Physical-Chemistry) we develop instruments to the Hunveyor-2 university lander type robot. One block of the experiments is the gas chemistry on a hypothetical planetary surface. (Especially we focus to search for such molecules on Mars and Europa.) In our research and undergraduate and graduate programs programming, robotics (construction), physics and chemistry of measurements are involved. Our laboratory facilities were prepared for students who build instruments onto the Hunveyor lander university space probe. [1,2]

REQUIREMENTS
The instrument was planned to fulfill the following requirements: 1. Detection in ppb levels of a target molecule, 2. small and movable sensor head, 3. easy upgrade for different analytes, 4. Be able to operate both in liquid and in gas phase, even if the pressure of the environment changes, 5. Work together with the on board camera, 6. Small power consumption (working from solar panel energy source), 7. Communicate with the on board computer of the lander. Such requirements can be used both for a lander or rover equipment. We think that optical chemical sensors could fit these requirements.

OPTICAL CHEMICAL SENSORS
In our earlier work we used an optical chemical sensor device first developed for blood gas analysis [3]. Such sensors are capable to monitor the dissolved gases or other chemical substances. If they were made more sensitive they would be able to observe ppb quantity of a molecule. A fiber optic sensor consists of a polymer layer placed to the end of a fiber. Fiber optic can be moved easily to the required position, easily. The system has small mass, low energy consumption and by developing different sensor tips, different kind of molecules could be detected. Therefore multiple specific sensors could be integrated into a single instrumental system.

In general, a fiber optic chemical sensor device consists of 1) a selective sensing layer, 2) which placed on one end of an optical fiber and 3) of a small electro-optical instrument, which measures the changes of the optical property of the sensing layer at a given wavelength.

In our recent developments we focused on gases, especially on ammonia (NH_3).(while the measurements of oxygen (O_2), sulfur-dioxide (SO_2) and hydrogen-sulfide (H_2S) [4,5] were also considered). The selected compound(s) is(are) present in the Martian atmosphere and also in the evaporated surface region of Europe. By using the sensors for Antarctica ammonia (NH_3) detection they could indicate remnants of fossil living tissue [6] or even ice-meteorite from the outer Solar System.

EXPERIMENTAL: THE NEW OPTICAL GAS SENSOR
Usually the sensing parts (the chromo-ionophore and the other chemical additives) of an optical sensor are dissolved in a plasticized polymeric membrane. The disadvantage of such kind of sensor is that the plasticizer could slowly evaporate especially at low pressures. This could result in a change of the sensor function. To overcome this problem a novel, plasticizer free sensor for ammonia gas was constructed.

The Hunveyor's optical gas sensor was constructed as follows: The novel reflectance based optical sensor consists of an anodized aluminum surface on which the indicator was immobilized. To make a sensor the aluminum was anodized at first. A 10x50 mm^2 polished aluminum foil (thickness 0.1 mm) was cleaned and immersed into 10% NaOH solution for 30 seconds. It was then removed, washed three times with distilled water and put into the electrolysis cell containing 15% sulfuric acid. The anodizing was carried out for five minutes at 12 V DC using a second aluminum foil as counter electrode. After anodizing the foil was washed with distilled water and immersed immediately into a bromophenolblue containing solution (0.1 %) for ten minutes. Then it was washed and dried at 80 ^{0}C over night. A highly reflective yellowish sensor surface was obtained.

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The sensor was sensitive to ammonia in the 50-10000 ppb range. In the presence of ammonia the yellow surface changed to blue which was monitored. Both the forward and reversed response times varied with the concentration of the ammonia gas. By decreasing the concentration of the analyte the response time increased. Typically at low concentrations (below 200 ppb) the response was about 3-4 minutes while the reverse response time was found about 8-10 minutes.

MEASURING AND TECHNOLOGY

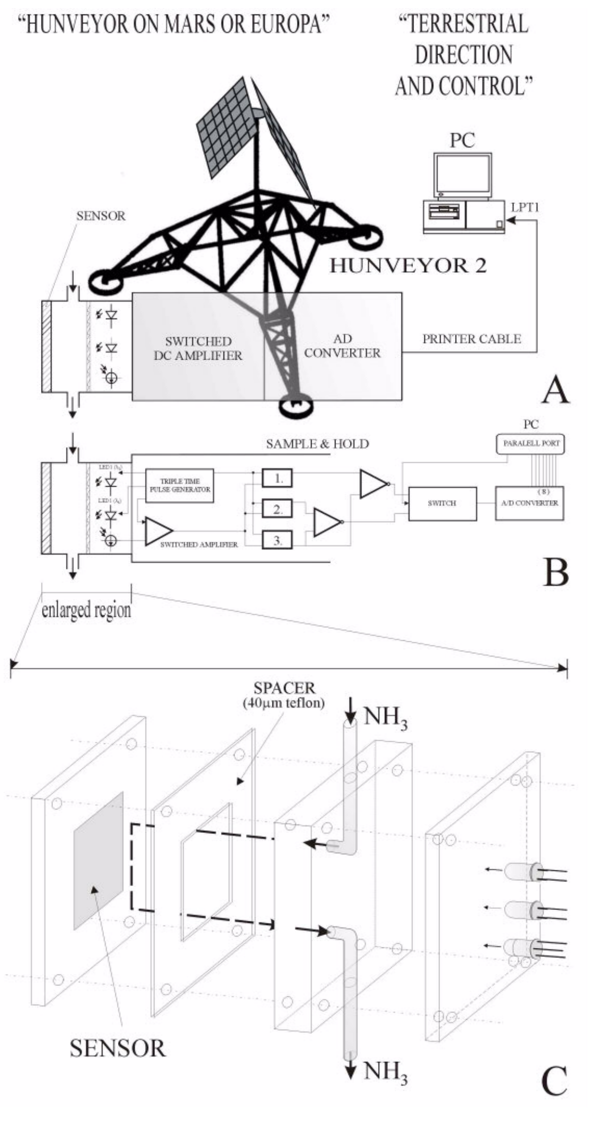

Fig.1. Schematic drawing of the sensor unit. A) Arrangement of the whole system. B) Detailed block diagram of the sensor unit, C) Enlargement of the sandwich-structure of the gas-measuring cell.

Description of the sensor unit: The analyte is pumped through the flow-cell. Two light emitting diodes (LEDs) having different wavelengths irradiate the sensor layer. A pulse generator was used to switch the LEDs on and off according to the following sequence:

1. phase one: LED1 is switched on. The reflected light is detected by a phototransistor, its signal is amplified and stored it in the first sample and hold circuit.
2. phase two: LED1 is switched off. The second LED2 diode is switched on. The reflected light is detected by a phototransistor, its signal is amplified and stored it in the second sample and hold circuit.
3. phase three: LEDs are off and the detector's dark current is measured and stored into to the third sample and hold circuit. Then a new cycle begins.

The light of the 2 different LEDs – one signal shortly after the other, in every 10 Hz units – is reflected from the sensor plate and reaches the amplifiers. The output signals of the detector are corrected with the dark current. This way the correction of the ambient light was performed. The amplifier outputs are switched alternating to the input of an AD converter. The output of the AD converter is connected to the LPT1 port of the computer. Further data analyses are made with the computer unit.

SUMMARY

A new optical sensing device for ammonia gas has been constructed for Hunveyor-2 experimental university lander of the Pécs University. The sensor has been prepared by immobilizing the ammonia sensitive dye on an aluminum-oxide surface. The novel sensor contained no polymer or plasticizer making it robust and more resistant to the environmental changes.

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