Annals of the Academy of Romanian Scientists
Series on Science and Technology of Information
ISSN 2066 - 8562 Volume **3**, Number **2**/**2010**

TOWARDS NANO-SCALE RESONANT GAS SENSORS

Cornel COBIANU[1], Bogdan SERBAN[2], Violeta PETRESCU[3], Julia PETTINE[3], Devrez KARABACAK[3], Peter OFFERMAN[3], Sywert BRONGERSMA[3], Vladimir CHERMAN[4], Silvia ARMINI[4], Faezeh ARAB HASSANI[5], M.A. GHIASS[5], Yoshishige TSUCHIYA[5], Hiroshi MIZUTA[5], Cecilia DUPRE[6], Laurent DURAFFOURG[6], Alexandra KOUMELA[6], Denis MERCIER[6], Eric OLLIER[6], Dimitrios TSAMADOS[7] and Adrian M. IONESCU[7]

Abstract. *In this paper, we present preliminary results in the field of resonant Nano-Electro-Mechanical Systems (NEMS), where the gas/bio detection is performed by the frequency shift due to mass loading of the adsorbed analyte. The sensitivity of the resonant NEMS chemical sensors based on SOI-CMOSFET technology platform and a given sensor geometry is theoretically proven to be equal to 1 Hz/zeptogram in mass loading for the case of a novel detector circuit based on MOSFET transistor. The minimum frequency shift of 1 ppm is designed for the case of an readout consisting of a MEMS/NEMS based oscillator. Piezoresistive detection circuits performed in SOI-CMOSFET technology are also investigated due to their attractiveness for integrated resonant NEMS sensors. Surface functionalization for NO_2 detection with CNT moieties is described, in accordance with the HSAB theory. Also, localized functionalization with NH_2 self-assembled monolayer followed by biotin attachment or Au nanoparticles decoration is experimentally proven within SOI-CMOS technology. Novel reliability challenges due to Wan Der Waals and Casimir forces acting in the nanometer gaps between different parts are identified. Finally, the noise limitations for the minimum detectable mass in resonant NEMS are shown. The adsorption-desorption noise on the functionalized surface appears to be the most important, and this may be in agreement with the kinetic theory of gases giving us a first indication of the number collisions per second per our sensing surface, in the range of* $2 \cdot 10^9$.

Keywords: surface functionalization, resonant gas sensor, integrated NEMS, NO_2 detection

[1]Honeywell Romania, Sensors and Wireless Laboratory, Bucharest, Romania; corresponding member of The Academy of Romanian Scientists.
[2]Honeywell Romania, Sensors and Wireless Laboratory, Bucharest, Romania.
[3]Stichting IMEC, Eindhoven, The Netherlands.
[4]IMEC, Leuven, Belgium.
[5]University of Southampton, Southampton, United Kingdom.
[6]Laboratoire d'Electronique et de Technologie de l'Information, Grenoble, France.
[7]Ecole Polytechnique Fédérale de Lausanne, Suisse.