MASS SENSITIVITY MEASUREMENT OF CHEMICAL RESONANT MICROCANTILEVER SENSORS

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The sorption of specific species by a sensitive layer deposited onto silicon microcantilevers modifies the mechanical properties of the structure, specially its fundamental natural frequency. This physical effect can be used to realize a chemical sensor. Usually, the vibrating structures are parallelepiped-shaped or standard AFM V-shaped microcantilevers with sensitive coating over the whole structure [1-2].

In order to improve the performances of such sensors, various shapes have been studied. Then, the resonance frequency and sensitivity expressions have been derived and an optimization of the material, size and shape has been performed [3]. To facilitate the frequency measurement and to have a large sensitive surface it is interesting to set up a rectangular plate at the free-end of the cantilever. According to this optimization, such structures have been realized at the ESIEE group (fig.1).

Targeting a full compact microsystem, the excitation source (piezoelectric or electromagnetic) as well as the semiconductor strain gauge etched on the cantilever surface, dedicated to detect the structure oscillations. The figure 2 presents the block diagram of the electrical oscillator recovering the cantilever resonance frequency.

According to the application, the active sensing material may be an organic polymer or a metal. In our case, to detect humidity and volatile organic compounds the PEUT (polyetherurethane) has been chosen [4]. This polymer is deposited, onto one side of the cantilever, by spray coating. For the calibrations of the spray coating system, the thickness of the deposited film has been measured by MEB.

The measurements results was realized with two kinds of structure (fig. 1) labelled **IIC5** (L=2mm, b_1=400µm, b_2=1mm, h_1=70µm) and **IIC8** (L=3mm, b_1=400µm, b_2=2mm, h_1=70µm). L is the total length, b_1 the cantilever width, b_2 the square plate width and h_1 the cantilever thickness. Under these conditions, the resonance frequency f was collected versus PEUT thickness as it is depicted in the figure.3. Obviously, one can notice that the cantilever resonance is mass sensitive. Then, the relative gravimetric sensitivity $S=\Delta f/f_0(\Sigma/\Delta m)$ has been deduced (fig. 4) and can be compared to the theoretical value $1/(2\rho_1 h_1) = 3$ obtained when the mass modification is taken into account. As it was predicted, this value is frequency independent. Using the partition coefficient K (relative to the sensitive coating and gas), the gas concentration sensitivity, $S_{Cg}=\Delta f/\Delta C_g$, can be estimated as a function of the polymer thickness (fig. 5). The gas concentration sensitivity increases with the resonance frequency f_0. As chemical sensor IIC5 is better than IIC8. According to figure 5, a large sensitive layer thickness seems to be better but in that case the oscillator noise growing up with polymer thickness, must be taken into account

Fig 1: Microcantilevers realized at ESIEE (IIC5 and IIC8)

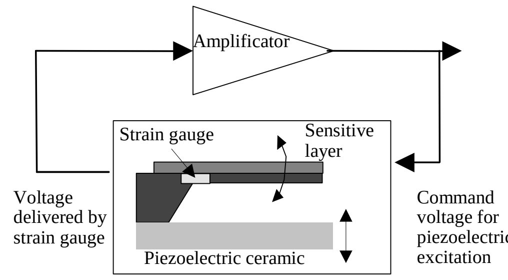

Fig 2 : Ring oscillator

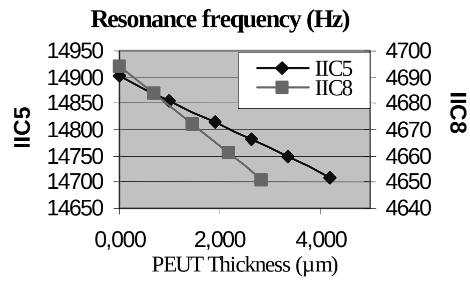

Fig 3 : Measured frequency versus PEUT thickness

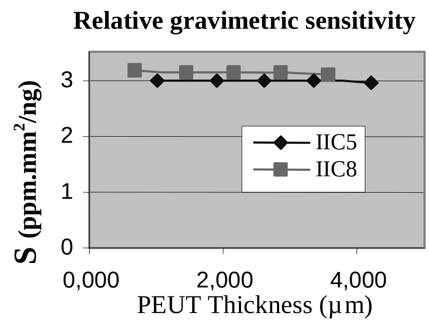

Fig 4 : Deduced relative gravimetric sensitivity S

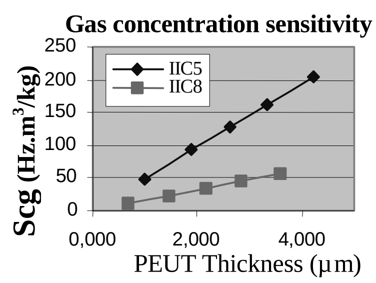

Fig 5 : Deduced gas concentration sensitivity

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