BIODETECTOR USING ACOUSTIC DEVICES : COMPARISON BETWEEN LOVE WAVES AND QCM

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The first applications of acoustic devices to chemical detection were proposed by Sauerbray in 1959 [1]. For application in liquid media, mainly quartz microbalance (QCM) sensors have been investigated. Recent works on Love waves devices for gas detection have demonstrated definitely their superiority, in particular in term of mass loading effect sensitivity [2]. As the shear horizontal polarization allows working with an adjacent liquid, three years ago, we decided to demonstrate similar potentialities for biochemical detection. An interdisciplinary and successful collaboration between immunologists and electronics researchers allowed real-time detection based on an immunological model with a Love wave device [3].
In quite the same time, a German team has led similar works with the same immunological species on QCM devices [4]. They used very sensitive QCM devices, obtained by locally thinning quartz crystals, which allows to realize high fundamental frequency (HFF) QCM.

We propose here to present some typical results obtained with Love waves devices applied to the detection of the bacteriophage M13. For example, responses to three concentrations of this bacteriophage in the liquid sample are reported on figure 1. These results are analyzed and compared with those obtained with QCM. We compare in particular the devices sensitivities and response times.
With QCM devices, the best results presented in [4] are obtained with the highest fundamental frequencies. At 70 MHz, a concentration of M13 bacteriophage equal to 10^9 PFU.mL^{-1} (PFU: Plaque Forming Units) induces a frequency shift of -410 Hz after 10 minutes. With the Love waves device working close to 87 MHz, and a concentration equal to 1.6×10^9 PFU.mL^{-1}, the frequency shift is about -1.15 kHz after 10 minutes (Fig 1).
Furthermore, the Love waves device frequency continues decreasing and reaches about -6 kHz after two hours. This shows the greatly higher sensitivity of Love waves, if we can wait for steady-state.
When the analysis time must be shortened, the Love waves sensor response can be data processed to analyze the transient part and detect or even quantify the target species after only a few minutes.

In conclusion, even if experimental conditions for tests with Love waves devices have to be improved to ensure a better detection level, and although very high fundamental frequencies QCM devices had been used, it is shown that Love waves remain very promising. They offer several advantages upon QCM and other acoustic waves, as their high sensitivity, but also their robustness and planar collective manufacturing.

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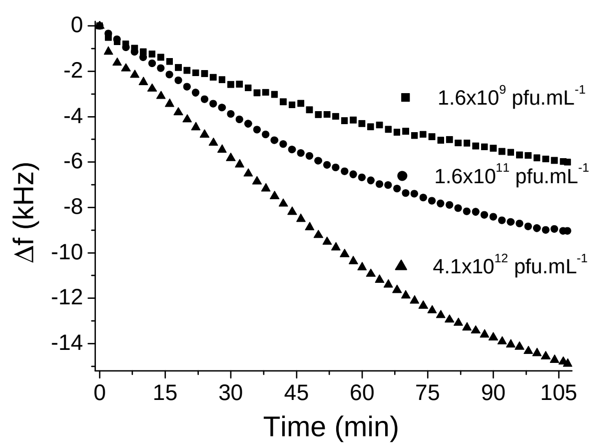

Fig. 1. Love waves sensor response versus bacteriophage concentration