IEEE UFFC 2004 Conference - Abstract 2805

Techniques to evaluate the mass sensitivity of Love mode surface acoustic wave biosensors

Laurent A. Francis [a,b], Jean-Michel Friedt [c], Randy De Palma [b,d], Cheng Zhou [b,d], Carmen Bartic [b], Patrick Bertrand [a], and Andrew Campitelli [b]

[a] PCPM, Université catholique de Louvain, Louvain-la-Neuve, Belgium. [b] Biosensors Group, IMEC, Leuven, Belgium. [c] LMN, Université de Franche-Comté, Besançon, France. [d] Department of Chemistry, Physical and Analytical Chemistry, Katholiek Universiteit Leuven, Leuven, Belgium.

With a shear horizontal polarization and a high mass sensitivity, Love mode surface acoustic wave (SAW) biosensors detect and quantify in real-time chemical species sustained in liquid environments. A Love mode is a guided acoustic mode generated in single or multiple layer coatings on a piezoelectric substrate. Love mode biosensors can be tailored in order to achieve desired parameters from both electrical and sensing points of view. To this end, the fine tuning of these parameters requires a set of proper methods to investigate experimentally the sensing properties and link them with theoretical models that take into account the material characteristics as well as instrumentation and physical effects occurring in the device during a biorecognition experiment.

In this paper, we investigate two experimental approaches that can be used to evaluate the mass sensitivity of Love mode SAW biosensors. The first approach is based on the analysis of the dispersion curve of the sensor, which helps to determine, either by simulation or derivation, a value of the mass sensitivity. In order to obtain the dispersion curve, we have performed a chemical wet etching procedure, which enables the continuous monitoring of the transfer function during the etching of the entire guiding layer.
The second approach is based on the addition and removal of layers in known quantities. The mass sensitivity is estimated in different cases: etching of a thin gold layer, copper electrodeposition, surface adsorption of an ionic surfactant or of a biochemical layer.
The results obtained by these techniques are compared between each others and with a theoretical model. In the theoretical model, the layered structure of the acoustic sensor is described in terms of mechanical transmission lines and the mass sensitivity is calculated using the dispersion relation and the phase and group velocities. The model takes into account the design of the device, the influence of a liquid cell and the parasitic effects linked to the instrumentation. From this model, we extract the theoretical mass sensitivity of a multilayered system.
Further improvements of the model must address Love mode SAW biosensors with piezoelectric, semiconducting or porous guiding layers.