Success Story
COMET

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A new tool for the simulation of micro-acoustic devices

Microacoustic devices are ubiquitous. They are core signal processing components in every smart phone (SAW RF Filters) and can also be used to accurately sense temperature and deformations in harsh environment. In order to develop ever more performing microacoustic components and sensors for various applications, CTR AG needed a high-performing simulation tool. The tool was successfully developed over the last four years in collaboration with the TU Vienna. Based on FEM simulations and semi-analytical models, the software makes it possible to fully compute the properties of a whole range of microacoustic devices.

What is it about?

Huge R&D efforts worldwide are dedicated to the development of ever better performing Surface Acoustic Wave filters (SAW), to answer the fast growing demand and always tougher specifications of the Smart Phone industry.

One important challenge is to achieve higher-frequency (5GHz), wide-band, low loss filters, to improve the performances of the emission/reception electronics.

Important efforts are also dedicated to the development of SAW wireless and passive sensors for harsh environment (very high temperature, corrosive atmospheres, nuclear plants…) and biomedical applications (implantable sensors).

Although CTR is already one of the world leaders in the field of SAW sensors, the Micro-acoustics development team was still in need for an advanced simulation tool to strongly improve its design and innovation capabilities whilst drastically reducing the development lead-times.

The needed tool was successfully developed over the last four years, in strong collaboration with the institute of mechanics and mechatronics of TU Vienna. A full PhD was dedicated to the development of the tool, based on proprietary FEM software (CFS++) coupled to a series of modules (semi-analytical models) developed at CTR.

More specifically, the FEM Module is able to quickly compute the properties of surface acoustic waves and bulk acoustic waves propagating within or interacting with the inter-digital transducers and reflectors that are used to generate, pick-up and reflect the acoustic waves. As some modes can result in spurious signals that shall be eliminated to improve the signal-to-noise ratio, the computation of all these properties make it possible to accurately simulate then optimize a wide range of microacoustic devices. The parameters obtained at the end of the FEM computation are subsequently used to compute the actual frequency or time response of a SAW

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device, as well as its sensitivity to temperature changes and/or deformation.

The effects of the surrounding circuitry (antenna, printed circuit board, housing…) can also be computed. It is for instance possible to simulate the response time and the sensitivity of a whole sensor when submitted to temperature changes. This makes it possible to fully optimize each of the sensors constitutive elements, for one given application.

In Fig. 1, we present the results of the FEM simulation of a surface acoustic wave propagating on top of a Lithium Niobate crystal. In Fig. 2, we show the results of the whole simulation of one of CTR implantable SAW sensors, dedicated to the measurement of the intra-cranial pressure after surgery. The peaks correspond to the echoes sent back to the reader by the implantable sensor. The pressure information is encoded in the respective position of the peaks.

It is stressed here that the only required information to compute the sensor's signal were the material parameters and the geometry of the inter-digital transducer.

Indeed, it is now possible to compute the main characteristics of a whole SAW sensor (including transfer function, pressure and temperature sensitivities) from the knowledge of the basic properties of the crystal and transducer(s) only (material tensor data, number, width, length thickness and position of the finger-like electrodes). Fig. 2 shows a good correspondence between computed and observed signal peaks,

Impacts and perspectives

Thanks to this new tool, CTR Team is now able to model, simulate and optimize a whole new range of innovative micro-acoustic devices. Especially, the tool will help develop the next generation of multilayered SAW filters, for the mobile phone industry. This is a challenging task, with highly promising outcomes. It will also help developing the next generation of CTR SAW sensors, for biomedical and industrial applications. Existing CTR sensors for very high temperature will also benefit from the tool, which makes it possible to further optimize the whole circuitry/housing/sensing architecture. The main applications here are for the steel, automotive and air and space industries.

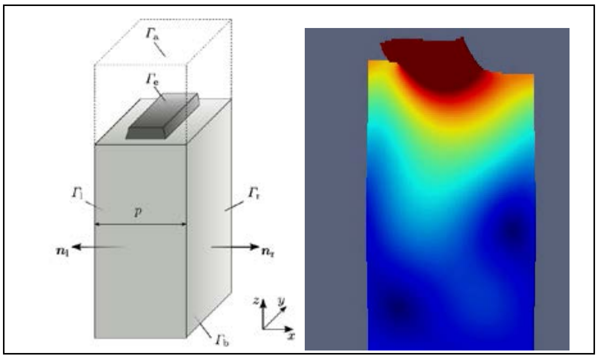

Fig. 1: Simulation of a Rayleigh wave propagating on the surface of a Lithium Niobate crystal. Left: model (crystal and electrode). Right: simulation results showing the deformation field in the crystal at resonance frequency.

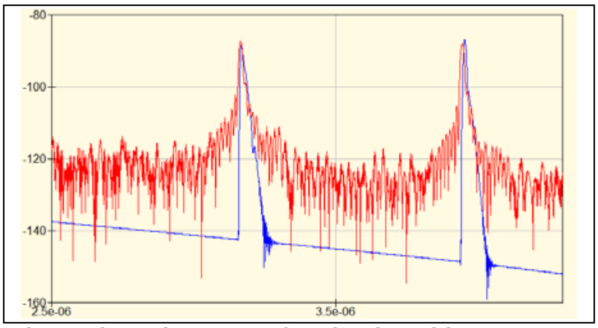

Fig. 2: time signature of an implantable CTR SAW pressure sensor (simulation vs. experimental). The peaks correspond to echoes sent back by the sensor. The pressure information is encoded in the position of the peaks (the electronics noise was not simulated).

Contact and information

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