2D hierarchical dielectric analysis of electrode array using FreeFem++

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In order to solve the 2D physical simulation of surface acoustic waves (SAWs) transducer infinitely periodic in one direction, we proposed in 2013 [1] an original Variational Formulation (VF) which formally includes harmonic periodic boundary conditions, and, efficient boundary integral formulations allowing to account for the semi-infinite dielectric and piezoelectric spaces. In the case of the piezoelectric semi-space, the Green's functions are efficiently computed using Fahmy-Adler's method. In a second step, SAW designers uses the harmonic admittance of the infinite periodic array of electrodes to derive a P-matrix simulations for finite SAW transducers.

In most cases, the transducers used in SAW devices consists in the concatenation of few basic cells. In that purpose, in 2018 Koskela et alt. [2] proposes an original technique called hierarchical based on the analysis of the basic cells followed by the removing of the internal nodes (sub structuring) and a on a tree concatenation to derive the analysis of the whole transducer. This new technique requires Perfectly Matched Method (PML) able to take into account piezoelectric and dielectric semi-spaces.

As a preliminary step, only a dielectric analysis of the electrode array with static PML has been studied. We will present a 2D implementation of this technique using FreeFem++, and compare with Green's function simulations and measurements.

[1] F. Hecht, P. Ventura, P. Dufilié, ″Original coupled FEM/BIE numerical model for analyzing infinite periodic surface acoustic waves transducers″, Journal of Computational Physics 246 (2013) 265-274.

[2] J. Koskela and V. Plessky, B. Willemsen, P. Turner, B. Hammond, N. Fenzi, ″Hierarchical Cascading Algorithm for 2D FEM Simulations of Finite SAW Devices″, IEEE Transactions on Ultraosnics, Ferroelectrics, and Frequency Control, Vol. 65, Issue 10, 2018, pp. 1933-1942.