# Efficient, Selective Piezoeletric Wave Transduction Using Interdigitated Electrodes

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## Abstract

Piezoelectric transduction is now a ubiquitous technology for exciting and detecting vibration in engineered systems. One of the most common classes of transducer is the Inter-Digitated Transducer (IDT), which is capable of exciting a rich vocabulary of wave types and corresponding modes in finite structures, including bulk SH, SV, and P waves, Rayleigh waves, Lamb modes in plates, and many others (see Fig. 1). It is often of significant importance from a design perspective to be able to control the response structure in terms of the types of wave generated. In particular, for Surface Acoustic Wave (SAW) devices, bulk waves are a common and undesirable source of spurious signals and concomitant error.

Research and development development work aimed at producing the next generation of biological and inertial integrated sensors using MEMS and semiconductor manufacturing technologies is ongoing, and constitutes one of the primary objectives in the field of microsystems. Biological sensors are required to operate in a fluid environment without undue attenuation of the vibrational motion. Signal to noise ratios are adverse, and spurious signals are a major difficulty from a control perspective. To this end, it is of considerable practical significance to develop transducers capable of generating an in-plane Love wave when operated in an appropriate geometric configuration, while suppressing the generation of both bulk waves of all types and Rayleigh surface waves. The data and models presented here arose in this context.

In the present work, classical IDT theory based on Coupling of Modes is evaluated and contrasted against numerical results generated in a COMSOL Multiphysics® simulation. A Frequency Domain study is employed for the purpose, built on the Piezoelectric Devices (PZD) physics interface. Spurious reflection is suppressed using an absorbing boundary condition, and the resulting free space frequency response structure for the different wave types is decomposed and reported. The effects of geometry and anisotropy are included for different material microstructures relevant in microsystems transducer design. Conclusions are drawn regarding figures of merit and corresponding principles of design for a given application goal, both in narrow terms of a Love wave biosensor and more generally.

## Figures used in the abstract

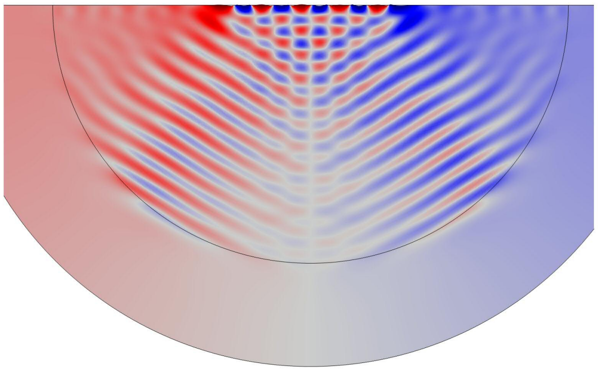

**Figure 1**: Generation and propagation of SV, P, and Rayleigh waves in a two-dimensional piezoelectric material.