Near-Field of Resonating Piezoelectric Membrane Used As Ultrasound Transducer

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Abstract

Micro-machined ultrasound transducers have a wide range of applications. As a sensor or actuator they can be used for measuring fluid speed and direction, to mix and excite particles (sonication), for taking images (ultrasonography), for non-destructive testing and many other purposes in wide variety of fields.

For this particular study, a simplified model of micro-machined piezoelectric membrane has been built. It consists of a circular Aluminum Nitride piezoelectric layer (80um in diameter) in between two Aluminum electrodes and an air or water domain where the pressure field propagates. The model of the transducer uses multi-physics coupling between Acoustics, Solid Mechanics and Electrostatics. In a Stationary Study, the model computes the static displacement of the transducer membrane. Also, the frequency of the first resonant mode is computed by using the Eigenfrequency Study. As the resonant frequency matches with the experimental one, we proceed by using the Frequency Domain to take advantage of the Acoustics module and compute the pressure field produced by the transducer. The simulated pressure field is going to be compared with experimental measurements for validation. In order the transducer to be simulated as a sensor, a Stationary Study is used where a boundary load is defined over the top electrode. This is used for optimization of the top electrode which ideally must be in contact only with the positive or the negative charges produced by the piezoelectric material.

This model has the ability to show how design decisions can optimize the top electrode for better ultrasound actuating and sensing. Also, how different thicknesses and radii of the membrane alter the performance, and finally how the internal damping of the aluminum electrodes can play role at high frequencies.

Figures used in the abstract

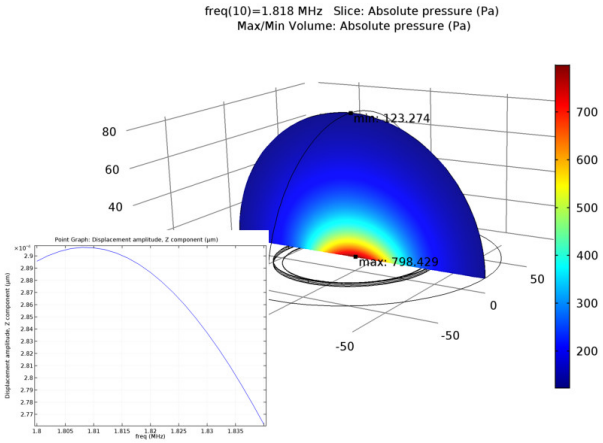

Figure 1: Absolute pressure in water of a micro-ultrasound transducer at resonance.