2D Simulations of Piezoelectric PDEs as a Basis for Electrode Shape Optimization

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Piezoelectric materials are nowadays present in many areas from high-end to everyday life applications. Their ability, the so-called piezoelectric effect, is to generate an electrical discharge as a response to mechanical stresses and vice-versa. This piezoelectric effect depends on material parameters. Therefore it is of crucial importance to determine these parameters. One possibility to obtain this information is via measurements, however this implies large experimental costs. A more efficient approach is to employ only electrical impedance and the sensitivities with respect to the parameters of the piezoceramic and use this information to solve an inverse problem to obtain the material parameters.

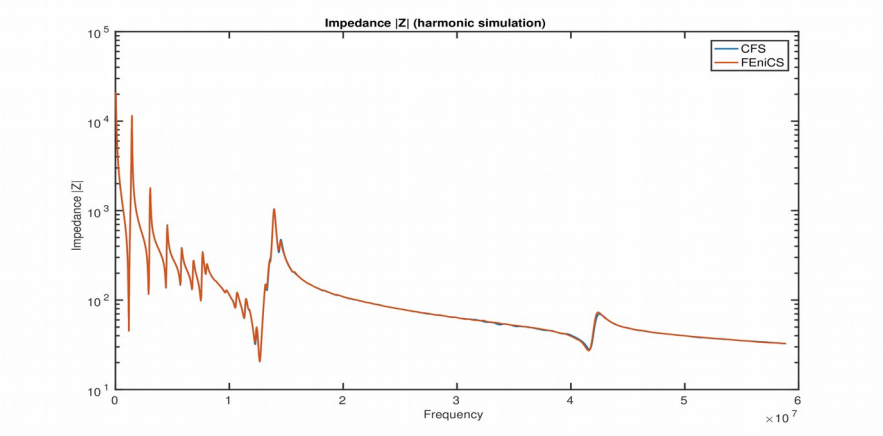

Figure 1: Impedance simulation of a 2D piezoceramic disk model.

We consider a rotationally symmetric 2D representation of a piezoelectric ceramic disk which behaviour can be described by a damped 2nd order PDE system with neglected thermal effects. As the first step two different FEM-based simulations are performed using FEniCS and CFS++, in order to compute the impedance for given material data, see Figure 1. Next, by using the measured or simulated impedance, we are able to compute the sensitivities with respect to the material parameters. Certain sensitivities are too low and have to be increased.

For this reason we employ shape or topology optimization approaches for electrodes on top and bottom of the piezoceramic, to increase the sensitivities for an improved solution of the inverse problem.

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