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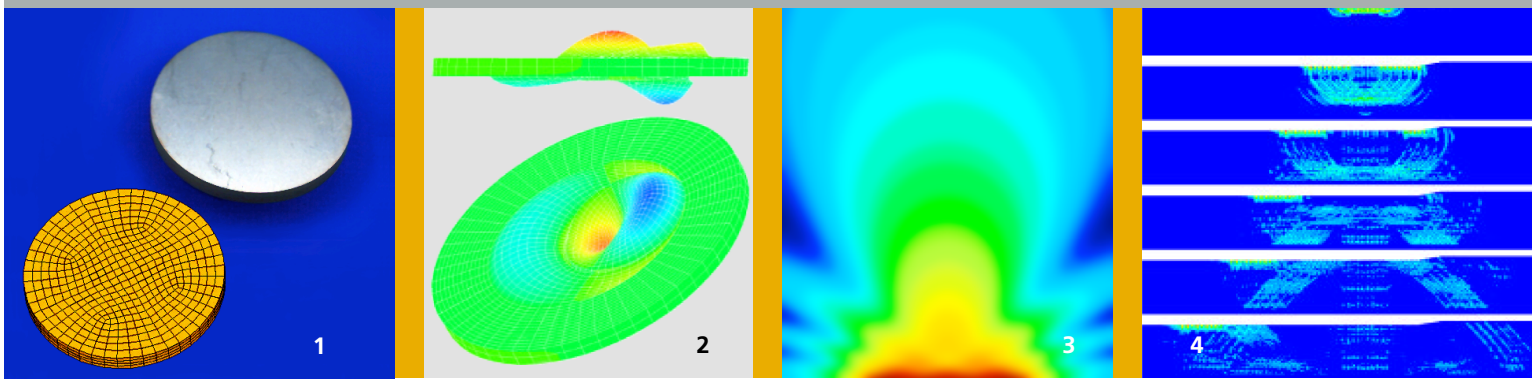

1 *PZT ceramics sample and corresponding FEM model.*
2 *Mode shape of a ceramics-metal sandwich structure.*
3 *Axisymmetric sound field of a simple piston type transducer.*
4 *Propagation of high-frequency ultrasonic waves in a SAW filtering device.*

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COMPUTER AIDED SENSOR DESIGN

Description

Conventional design and continuous improvement of ultrasonic transducers is a time-consuming and costly process. This is due to the fact that the characterization of various transducer models cannot be performed until complete manufacturing.

Computer simulations combined with empirical tests result in a minimized effort for the transducer design.

The Group Simulation and Advance Development at the Fraunhofer IBMT employs a variety of methods and software tools and provides very effective guidelines for transducer design optimization and construction, based on the customer`s project specifications.

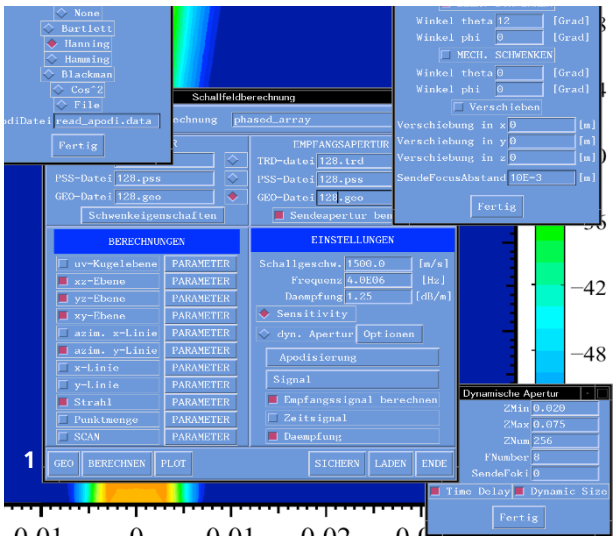
CAD

The software package SolidWorks is employed to build the transducer model. The large variety of available interfaces makes the direct transfer of data into the simulation programs as well as into CNC-controlled manufacturing machines very convenient.

FEM

Using the geometrical data from SolidWorks, the FEM tools PZFlex and ANSYS simulates the vibrational behavior of the transducer at different frequencies and boundary conditions.

Employing the finite element method the complex geometry of the model is divided into small, but geometrically more simple elements. The physical equations describing the system are numerically solved for the



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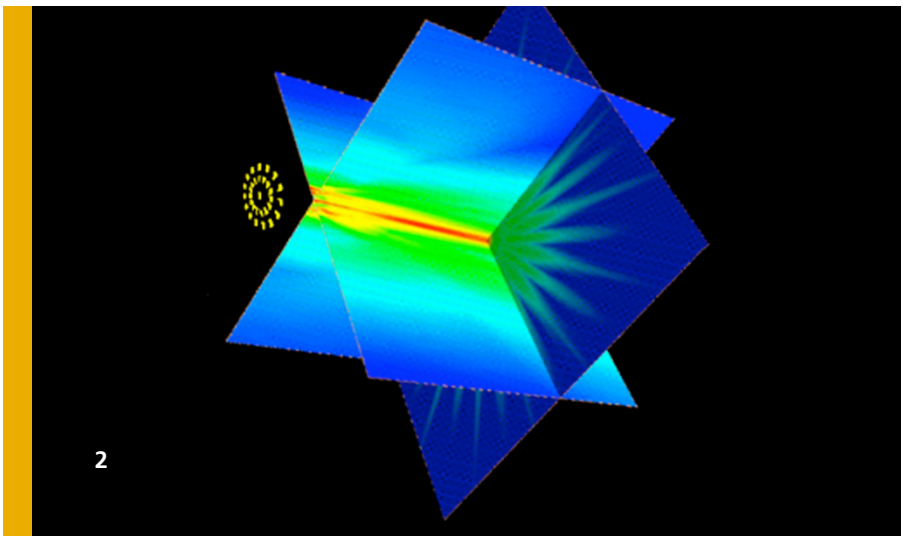

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elements which are then assembled to get the complete solution. Finally the vibrational shape of the ultrasonic transducer is visualized and optimized.

Material Properties

The FEM simulation of piezoelectric ceramics requires 11 independent material parameters. Those values are difficult to measure and they vary due to process conditions. So often only a small amount of those parameters is known with a sufficient accuracy and only for a special batch of the ceramics.

At Fraunhofer IBMT a method based on genetic algorithms and evolutionary theory was set up to estimate unknown parameters and to fit them within given boundaries. Characteristic properties like the electrical impedance spectrum is measured from given samples. The program can vary the material parameters in the FEM model of the sample with the goal of getting a good agreement between measurement and simulation results.

Sound Field Simulations

A software package developed at Fraunhofer IBMT is employed to examine ultrasound propagation into different media. The method, based on the Kirchhoff-integral, visualizes the wave propagation.

The transducer aperture is represented by single points. The sound field at a particular location is calculated as a superposition of the emitted waves of the single points.

An integrated preprocessor can generate single element transducers as well as linear and 2-D arrays. They can be driven at a single frequency, with a preset burst or with arbitrary defined time signals. The sound field can be visualized on arbitrary planes and lines in the propagation space.

An add-on module allows to simulate phased array systems. So one can study the influence of dynamic aperture and time delay patterns on the sound field and optimize the transducers with respect to that. The control parameters of ultrasonic systems can also be improved by simulating the beamforming process in a computer model rather than on the real system.

Our Offer

Starting from the specifications of the customer, ultrasonic sensors can be designed, generated, tested and optimized in a computer model. Material properties are either available in our database or can be retrieved by measurement of suitable samples. They can be fitted within the tolerances and measuring insecurity with our optimization program.

Measuring capabilities available at Fraunhofer IBMT make it easy to verify the models at different stages up to quality control of the prototype or serial transducer.

With our capabilities the conception of ultrasonic transducers for different and specific purposes is fast and of low cost.

1 *User interface of the sound field calculation program.*

2 *Sound field of an ultrasonic 2-D array.*