

Zsolt Vízváry:

Electrical-, Mechanical- and Thermal modelling of Micromechanical Structures

THESES

1. I derived the coupled piezothermoelastic equations using a modified hyperbolic equation of heat conduction (suggested by CATTANEO and VERNOTTE). The equations using Fourier's law are already known. The hyperbolic equation of heat conduction is more adequate in micro scale. The equations are valid for homogenous, linear elastic, anisotropic material. The variables of these equations are the displacement, the temperature difference and the electric potential. They can be the variables of the finite element equations as well.
2. I discretized the coupled piezothermoelastic equations using Galerkin's method with
 - the classical Fourier's law.
 - the modified hyperbolic equation of heat conduction.Finite element algorithm can be based on the obtained matrix differential equations.
3. I developed an own finite element code in Fortran to solve coupled piezothermoelastic problems based on the equations derived in 2nd thesis. I used direct solution strategy to solve the equations. Sequential strategy can be applied too, but the direct strategy allows to take more difficult material laws into account in the future.
4. I presented results of thermomechanical analysis for real micromechanical structures. The effects of geometrical parameters on the behaviour of structure are showed on a capacitive type accelerometer. The effect of boundary conditions and material types are presented on an isolated, suspended gas sensor.
5. The elasticity modulus measurement of deposited silicon-nitride layer was described. Silicon-nitride is a widely used structural material in MEMS applications because of its electrical and thermal properties. But its mechanical properties are given in a wide range in the literature. The Young's modulus can be determined from the first natural frequency of thin cantilever beams formed from silicon-nitride layers. The elasticity modulus, which is the most important mechanical parameter for structural modelling, was calculated both from analytical and finite element models.