Modeling of plates with multiple anisotropic layers and residual stress

Usually the analytical approach for modeling of plates uses the single layer plate equation to obtain the deflection and does not take anisotropy and residual stress into account. Based on the stress–strain relation of each layer and balancing stress resultants and bending moments, a general multilayered anisotropic plate equation is developed for plates with an arbitrary number of layers. The exact deflection profile is calculated for a circular clamped plate of anisotropic materials with residual bi-axial stress. From the deflection shape the critical stress for buckling is calculated and by using the Rayleigh–Ritz method the natural frequency is estimated. Using the Galerkin method, an approximate deflection shape is calculated for a rectangular plate, and for a square plate the expression can be simplified drastically. To support the results, the model has been compared to a FEM model, and an excellent agreement between the two models is seen with a relative difference of less than 2% for all calculations. The model was also used to extract the cell capacitance, the parasitic capacitance and the residual stress of a pressure sensor composed of a multilayered plate of silicon and silicon oxide. The extracted values were in good agreement with the expected and it showed that the behavior of devices with a plate could easily be predicted with a low uncertainty.

General information
Publication status: Published
Organisations: Department of Micro- and Nanotechnology, MEMS-AppliedSensors, Silicon Microtechnology
Contributors: Engholm, M., Pedersen, T., Thomsen, E. V.
Number of pages: 10
Pages: 70-79
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Sensors and Actuators A: Physical
Volume: 240
ISSN (Print): 0924-4247
Ratings:
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.79 SJR 0.787 SNIP 1.609
Web of Science (2016): Impact factor 2.499
Web of Science (2016): Indexed yes
Keywords: Anisotropic plate theory, Micromechanics, Stress, Multilayers
Electronic versions:
Manuscript_123.pdf. Embargo ended: 07/02/2018
DOIs: 10.1016/j.sna.2016.01.054
Source: FindIt
Source ID: 2291754282
Research output: Contribution to journal › Journal article – Annual report year: 2016 › Research › peer-review