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Analytical and FEM Modeling of Piezoresistive Silicon Accelerometers: Predictions and Limitations Compared to Experiments

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An important step in the development of any new silicon micromechanical structure is the theoretical predictions of the characteristics for a given device. This paper reports on the calculation with analytical formulae and finite-element modeling (FEM) for two basic types of silicon piezoresistive accelerometers (bridge type and cantilever type). Whereas classical formulae show in a straightforward manner the dependence of the sensitivity and resonance frequency on various design parameters, their application is limited to simple structures and configurations. More detailed and complementary results are predictable using FEM analysis in the case of complex structures or of existing passivation layers. The thickness of the beams is given by the fabrication process, whereas other device dimensions must be optimized with respect to the desired characteristics. Modeling is then very useful, and its predictions and limitations compared to experimental results are presented.

1. Introduction

The development of a new type of silicon accelerometer consists of three main steps: design including modeling, fabrication process and characterization. In order to reduce the development time, theoretical predictions are becoming more and more important. For the last five years, finite-element modeling (FEM) has been