ABSTRACT
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MEMS pressure sensor: modeling and measurements

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Demand for high performance, stable, and affordable sensors for applications in process control industry has led to development of a miniature pressure sensor. This development, made possible by recent advances in microelectromechanical systems (MEMS), utilizes polysilicon-sensing technology. The unique polysilicon piezoresistive sensor (PPS) measures differential pressure (DP) based on deformations of a multimaterial multilayer diaphragm, which is about 2 µm thick with some layers being merely 50 nm thick. Deformations of the diaphragm, subjected to changes in pressure, are sensed by piezoresistive bridge elements. Determination of the loading pressures from strains of the piezoresistors is based on computations relying on a number of material specific and process dependent coefficients that, because of their nature, can vary, which may lead to uncertainties in displayed results. To establish an independent means for measurements of deformations of the PPS diaphragms and to validate the coefficients used, we have developed a hybrid methodology, based on optoelectronic laser interferometric microscope (OELIM) and finite element method (FEM) coupled with uncertainty analysis provided by unique closed form formulations. This methodology allows highly accurate and precise measurements of deformations of diaphragms, as well as their computational modeling/simulations, and is a basis for "modeling and measurements" (i.e., M&M) approach to efficient and effective developments of new MEMS sensors and/or improvement of the existing ones. The measurements are made in near real-time with sub-micron spatial resolution while providing nanometer accuracy. In this paper we present the approach and illustrate its use by a representative example.

Keywords: MEMS, pressure sensor, differential pressure, hybrid methodology, M&M approach, uncertainty analysis, design by analysis.