Modeling and Simulation of Silicon Optical MEMS Switches Controlled By Electrostatic Field

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Abstract

Introduction
The use of optical sensors in the industry is still growing. A transmission of signal from the sensors is mostly done by optical fibers. Switching the signals from optical paths may be done by using micromechanical silicon switches. The main advantage is an ability to transmit data from many sensors using different wavelengths, simultaneously minimizing optical power losses. The construction of the optical switch is shown in fig. 1. A silicon beam with an Al layer is an actuating element. It is a mirror and an electrode of an electrostatic actuator at the same time. The second electrode is placed under the beam. A change in the electrostatic field causes a deflection of the beam.

The optical transducer consists of two fibers: the transmitting fiber T and the two receiving fibers R1 and R2. A light source lightens the moving mirror surface (the beam's surface) by the transmitting fiber. Reflected light is collected by the receiving fibers. Light intensity in the photodetectors (for the receiving fibers R1 and R2) depends on the deflection of the beam. By controlling a voltage supplying the electrostatic transducer, the light intensity collected by the receiving fibers R1 and R2 can be changed.

Use of COMSOL Multiphysics®
Two different constructions of an upper electrode were analized - a full 4x2mm electrode and an electrode with a cavity cut out on a half of its length. Fig. 3 shows result of the modeling for the mentioned constructions and different values of a gap between the electrodes. An influence of mounting of the cut-out construction on the values of electrode's displacement was tested (fig. 4).

The study shows an analysis of the electrostatic transducer controlling the silicon beam's displacement. COMSOL Multiphysics® 4.3b was used for the modeling. In the models, coupled mechanical and electrostatic fields were used (MEMS, AC/DC modules). The 3D distribution of electric field generated by plain electrodes of the transducers were analyzed. The application of an optical transducer in the presented construction is a topic of further analisys.

Results
The study shows results of modeling of the electrostatic transducer with the movable beam. The characteristics of the light intensity in the optical transducer in function of the controlling voltage

were analyzed for different parameters of the electrostatic transducer.

Keywords
silicon microactuators, MEMS, controlled by electrostatic field, modeling, optoelectronic system

Reference

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Figures used in the abstract

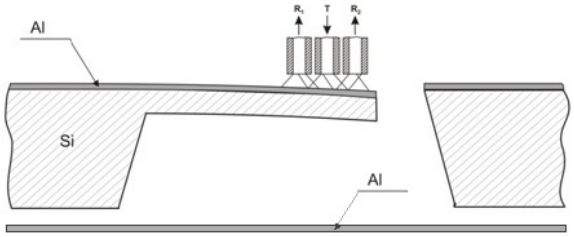

Figure 1: Construction of an optical fiber transducer

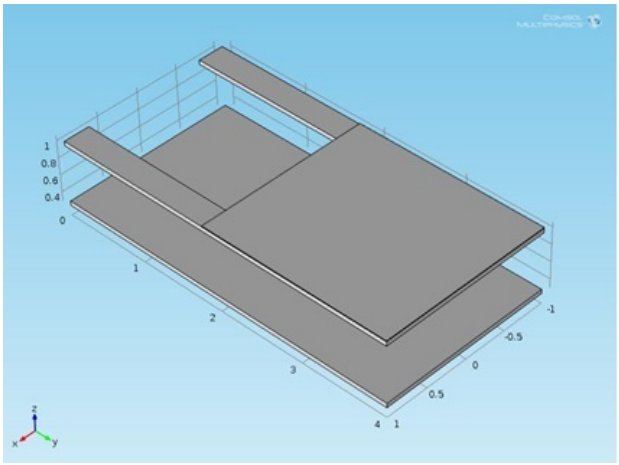

Figure 2: Model of a switch geometry in the Comsol

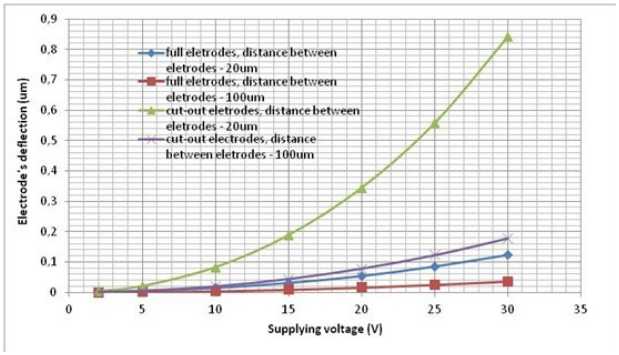

Figure 3: Eletrodes' deflection for different constructions and gaps between them, in function of supplying voltage

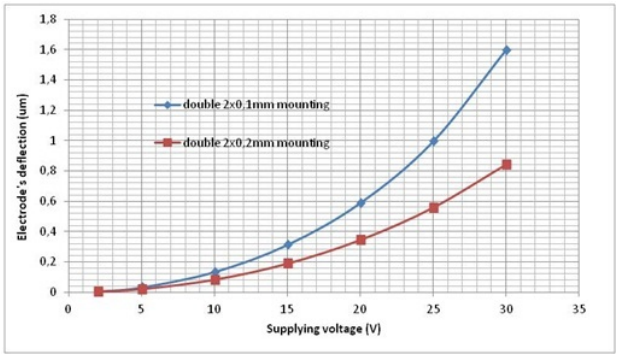

Figure 4: Influence of mounting of the cut-out construction on values of the eletrode's deflection