A Two-Layer MEMS Micromirror for Optical Scanning and Spatial Light Modulation

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Abstract: A MEMS micromirror capable of 3D operation with low insertion loss (~1dB) is presented. The device requires only two masks for fabrication and operates at CMOS voltage levels. The full switching speed is about 10-ms.

OCIS codes: (230.0230) General; (230.3990) General.

1. Introduction

Micro-opto-mechanical systems (MOEMS) have become the technology of choice for low cost scalable photonic applications. This paper presents a novel micromirror based on thermal actuation that overcomes many of the performance and manufacturability issues of previously proposed devices that require high actuation voltages, exhibit low displacements and forces, or rely on the use of complex fabrication processes sometimes even comprising exotic materials and post-processing microassembling steps.

2. Design and Experimental Results

An optimized microactuator that only requires two masks for manufacturing was designed as shown in Figure 1. The device consists of a single-layer polysilicon structure covered with a highly-reflective gold-coating film. The tip of the actuator forms a square micromirror plate. The actuating principle is based on differential thermal expansion of the two stacked materials when Joule-heating is generated by means of an input control voltage. The thermal analysis and mechanical deflection was estimated based on some of the methods comprehensively elaborated in [1, 2]. The length of the bimorph actuator is 185-μm, the lateral suspension flexures are 50-μm long, and the width and thickness of the beams are 10-μm and 1.5-μm respectively. The micromirror plate measures 35-μm by 25-μm. Figure 2 shows that the actuator displays excellent linearity with the control voltage. Measured power consumption ranges from 10 to 50 mW for input voltages within 1 to 5-V. The dynamic response achieves 10-ms switching times.

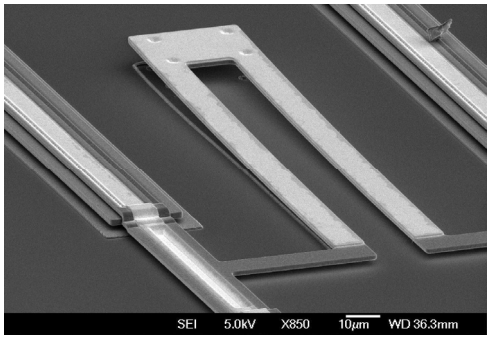

Fig. 1. SEM micrograph of the fabricated micromirror.

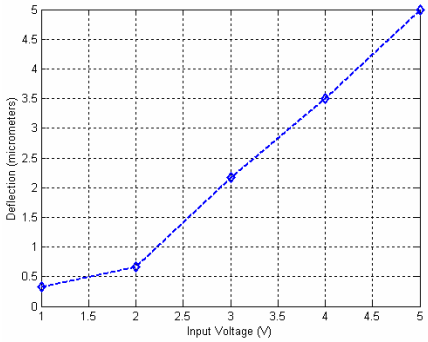

Fig. 2. Displacement of the actuator as a function of voltage.

3. Conclusions

A simple thermally-actuated micromirror that can be implemented in a standard fabrication process has been presented. The device is fully compatible with CMOS circuit technology that permits the integration of control electronics on the same substrate further reducing cost and volume. Its 3D (analog) operation feature is paramount in large multi-port crossconnect switches and servo-scanning optical applications.

References

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