A Large Stroke Inverse Series Connected Electrothermal Bimorph Micromirror Platform for Optical Applications

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Abstract— This paper presents a large stroke surface micromachined micro-mirror platform actuated using inverse-series-connected (ISC) bimorph actuator. The platform is capable of producing both piston and tip-tilt motion. With a mirror plate size of 500x500 μm^2, the maximum displacement is 100 μm in piston mode and 69 μm in tip-tilt mode at 0.2 V. The micromirror is capable of scanning with resonance frequencies at 4.31 KHz and 6.70 KHz in piston and torsional mode respectively.

Keywords: Micromirror, MEMS Actuator, Electrothermal Bimorph Actuator

1. Introduction

Micro-electro-mechanical system based micromirrors have found numerous applications in projection display, multi-object spectroscopy, medical imaging, scanning and optical communication switching. This paper presents an electrothermally actuated micromirror platform for large stroke piston and tip-tilt motion. The actuator is made using Inverse-series-connected (ICS) bimorph structure of Al and SiO_2. The proposed micromirror is made using surface micromachining without use of costly SOI or DRIE processes.

2. Device Design and Process Flow

3D schematic diagram of the proposed design is shown in fig. 1(a). The mirror plate is supported by four bimorph actuators. The actuator is composed of Inverse-series-connected Al and SiO_2 layer with Al also working as embedded heater as shown in fig. 1(b) . The ICS actuator effectively cancels the tangential tip and lateral shift resulting in enhanced upward motion. The inverted (INV) and non-inverted (N-INV) segments of SiO_2 are symmetric and overlapping of segments gives additional robustness. Thickness of bottom oxide, Al, and top dioxide is taken as 0.5 μm, 1.5 μm and 0.5 μm respectively.