Topic	Device Modelling and Simulation

Curvature Correction Methodologies for Micromirror Platforms Deformed Due to Residual Stress

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Micromachined devices are prone to post-release deformation due to the presence of residual stress in structural layers resulting in poor performance and reliability issues. This paper presents the effects of residual stress on the flatness of a bilayer micromirror platform and different curvature correction methodologies for the same. The micromirror platform under investigation consists of a rectangular plate of area 500x500 μm^2 fabricated using 0.75 μm thick SiO_2 and 0.95 μm thick aluminum and suspended by a set of bimorph actuators. The presence of compressive stress in SiO_2 (240 MPa) & tensile stress in aluminum (35 MPa) manifests itself in curling of the platform after release. The extent of deformation depends on various factors that include constituent layer thickness, the dimension of the platform, location of anchoring points and magnitude of residual stress. The stress-induced deformation of the micromirror platform leaves the device unsuitable for any useful optical application.

Finite Element Analysis of the platform is performed in Coventorware® to access the nature and extent of post-release deformation at ambient temperature due to the presence of biaxial residual stress. The distribution of residual stress is assumed constant across the film thickness i.e. without stress gradient. In order to correct the platform deformation, two methods of stress counterbalancing i.e. metal reinforcement framing and deposition of a stress compensation layer are proposed and their effectiveness in curvature correction is investigated using FEM analysis. The simulation result shows that a 1 μm thick gold reinforcement frame results in a 13 μm height difference between platform center and platform corner, which improves to a height difference of 6 μm for reinforcement thickness of 3 μm. Improved curvature correction is obtained with a stress compensation layer in which maximum height difference between platform corner and platform center is reduced to 1 μm for a SiO_2 layer of thickness 0.75 μm deposited at the top of aluminum. FEM analysis confirms that presence of stress compensation layer at the top is more effective in curvature correction compared to metal reinforcement framing, however; post-release elevation of the stress-compressed platform is 5 μm below the post-release elevation of the reinforced platform and 25 μm below the zero reference plane.

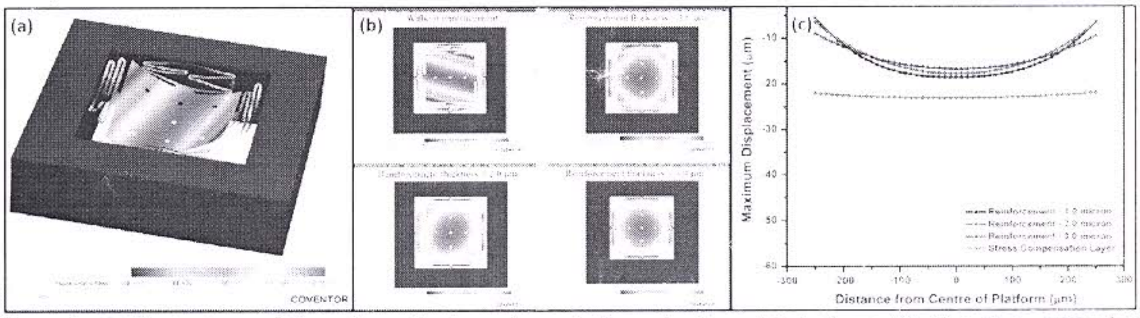

Figure 1. (a) Post-release deformation of micromirror platform due to residual stress. (b) Curvature correction using reinforcement framing and (c) Comparison of different curvature correction methodologies

References

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