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Analysis of Thermal Damping in Si Based Torsional Micromirrors

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Abstract : The thermal damping of a dynamic vibrating micromirror is an important factor affecting the design of MEMS based actuator systems. In the development process of new micromirror systems, assessing the extent of energy loss due to thermal damping accurately and predicting the performance of the system is very essential. In this paper, the depth of the thermal penetration layer at different eigenfrequencies and the temperature variation distributions surrounding a vibrating micromirror is analyzed. The thermal penetration depth corresponds to the thermal boundary layer in which energy is lost which is a measure of the thermal damping is found out. The energy is mainly dissipated in the thermal boundary layer and thickness of the layer is an important parameter. The detailed thermoacoustics is used to model the air domain surrounding the micromirror. The thickness of the boundary layer, temperature variations and thermal power dissipation are analyzed for a Si based torsional mode micromirror. It is found that thermal penetration depth decreases with eigenfrequency and hence operating the micromirror at higher frequencies is essential for reducing thermal damping. The temperature variations and thermal power dissipations at different eigenfrequencies are also analyzed. Both frequency-response and eigenfrequency analyses are done using COMSOL Multiphysics software.

Keywords : Eigen frequency analysis, micromirrors, thermal damping, thermoacoustic interactions
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