

Design Optimization of Piezoelectric Micro-machined Modal Gyroscope

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Abstract

A gyroscope is used to detect angular motion. Its applications involve orientation control; roll over detection in automobiles, image stabilization in photography etc. A solid state Piezoelectric Micro Machined Modal Gyroscope (PMMG) is a vibratory type of gyroscope which sense the motion by voltage induced due to Coriolis force. PMMG utilizes natural frequency of the structure to maximize the displacements and hence maximizing the induced voltage signals for sensing the rotation applied to the structure. Since there is only vibratory displacement hence no special packaging is required to safeguard the robust structure of PMMG. A simple cuboid structure made of PZT-4 is analyzed through finite element method using COMSOL Multiphysics®. The mode suitable for gyroscopic motion is 9th mode, which was found to be vibrating at 350.217 kHz. Later frequency domain analysis is done. With the voltage applied at 350 kHz the vibrating mode is found to be same as for the natural 9th mode. A design modification is introduced and its modal and harmonic analyses are done. The new structure is found to be vibrating at 3.064 kHz. Also the modified structure has two distinct vibratory modes which are symmetric making it ideal for dual axis sensing. Having lower modal frequency and larger vibratory amplitude causes increase in sensitivity of the gyroscope.

Reference

Xiaosheng Wu , Wenyuan Chen, Weiping Zhang et al., Yipeng Lu et al., Feng Cui et al., Modeling Analysis of Piezoelectric Micro machined Modal Gyroscope (PMMG), The 12th International Conference on Solid State Sensors, Actuators and Micro systems, Boston, June 8-12 pp. 1726-1729(2003).

Figures used in the abstract

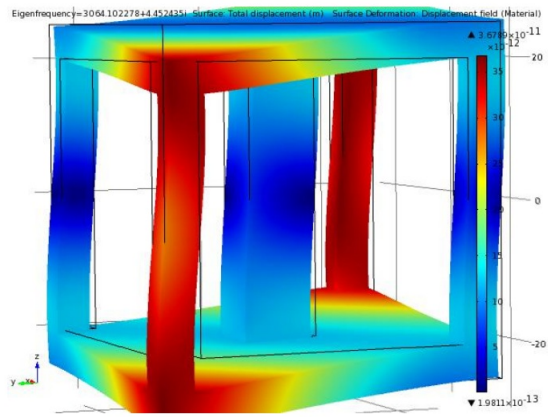


Figure 1: Symmetric mode 1

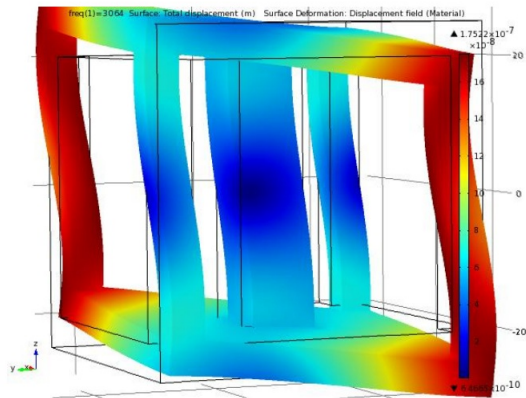


Figure 2: Symmetric mode 2