Cross Domain Modelling And Analysis Of A Meander Beam MEMS Accelerometer In COMSOL Multiphysics® And SPICE

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Abstract

In this work a bulk Silicon MEMS single-axis 8-beam accelerometer has been designed utilising meander beams in the Structural Mechanics and MEMS Module of COMSOL Multiphysics® as shown in Fig. 1.a. To obtain further insights into the design of the accelerometer, an electrical lumped element model of the structure is derived and represented in SPICE as illustrated in Fig. 1.b. Quantities such as eigenfrequencies and proof-mass displacement have been extracted from COMSOL Multiphysics® as well as analytical studies. The effects of parasitic frequencies in the structure are observed by automatic tilting of the accelerometer at higher order eigenfrequencies due to finite off-axis stiffness coefficients, as shown in Fig. 1.a. In order to mathematically quantify the response of the accelerometer arising due to parasitic frequencies, the transient damping response has been derived in COMSOL Multiphysics® as well as SPICE, and the differences are highlighted. Finally, the eigenfrequencies of the meander-beam accelerometer have been compared with that of a simple-beam accelerometer and the validity of small deflection theory is tested for the lumped model approach. While the target damping factor of the accelerometer was 0.7, the obtained damping factor increased to 1.1 due to the aforementioned parasitic frequencies. This effect was precisely captured during the COMSOL Multiphysics® simulations.

Figures used in the abstract

Figure 1