Design, Fabrication, Static Test and Uncertainty Analysis of a Resonant Microaccelerometer

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This paper investigates a resonant microaccelerometer using a laterally driven micromechanical resonator, whose resonant frequency is changed by the acceleration-induced axial force. In the theoretical study, design equations for the resonant microaccelerometer have been developed, including analytic formulae for the resonant frequency, sensitivity, nonlinearity and maximum stress in the mechanical structures. On this basis, the sizes of the accelerometer are designed for a sensitivity of $10^{-3}$ g/Hz over the bandwidth of 100 Hz, while satisfying the maximum nonlinearity of 5%, the minimum shock endurance of 100 g, the detection range of 5 g and the size constraints placed by the microfabrication process. A set of resonant accelerometers has been fabricated by the integrated application of bulk-micromachining and surface-micromachining techniques. In the experimental study, we have performed a static test of the cantilever beam resonant accelerometer. The frequency shift of 860 Hz has been measured for the provided proof-mass deflection of $4.3 \pm 0.5 \, \mu m$, thereby obtaining the detection sensitivity of $0.92 \pm 0.11 \times 10^{-3}$ g/Hz. From the uncertainty analysis based on the theoretical equations as well as the experimental data, we found that the major uncertainty in the frequency shift output comes from the uncertainties involved in the micromachining error, Young’s modulus uncertainty and proof-mass deflection uncertainty.