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Abstract

Dynamic Characterization of Biosensing MEMS Cantilevers with Different Position of the Driving Electrode—Vacuum Response Versus Ambient Conditions †

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Abstract: The influence of the driving electrode positions on the dynamic response of polysilicon MEMS resonators used in biosensing applications is studied as a function of the operating conditions (vacuum versus free-air operating mode). The scope of this research work is orientated towards identifying the effect of driving electrode position on the dynamic response of sensing MEMS used in biomass detection. The mass-deposition detection is based on the change in the resonant frequency of vibrating elements considering a biological detection film deposited on the oscillating structure. The operating conditions, such as medium pressure, change the behavior of the dynamic response including the resonant frequency, the amplitude, and the velocity of oscillations as well as the quality factor and the loss of energy. The change in the dynamic response of the investigated MEMS cantilevers as a function of the lower electrode position and operating conditions is evaluated using a Polytec Laser Vibrometer. The decrease in the amplitude and velocity of the oscillations if the lower electrode is moved from the beam free-end toward the beam anchor is experimentally monitored. The changes in the response of samples in vacuum are slightly influenced by the electrode position compared with the response of the same sample in ambient conditions. Moreover, the effect of oscillating modes (first, second and third modes) is taken into consideration to improve the dynamical detection of the investigated samples. The obtained results indicate that different responses of MEMS resonators can be achieved if the position of the driving electrode is moved from the cantilever free-end toward the anchor. Indeed, the resonator stiffness, velocity and amplitude of oscillations are significantly modified for samples oscillating in ambient conditions for biological detection compared with their response in vacuum.

Keywords: MEMS; Q-factor; dynamic response

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