Introduction

Charles Zhang

In contemporary society, the MEMS devices has done a significant role in many field, like fluid control, micro-power system, MEMS fuze system and internet of things （IOT）1 , because of its advantage like the scaling of MEMS devices reduces the cost per device although the total cost to fabricate one wafer. This is because the number of devices on each wafer increase dramatically with the decrease of the feature size of MEMS devices. In addition, the finer fabrication process provides high performance of MEMS devices, e.g. the accuracy and precision of MEMS sensors are orders of magnitude higher than conventional sensors. 2 Therefore, MEMS has become a focus of both fundamental research and applicable engineering. Among all the MEMS applications, the comb drive uses electrostatic force as the actuation principle. There are two metal conductor of micron scale, shape of the comb. They both alternate with each other where one is static and another not. When plus an alternating current, one of the comb will be relative to another conductor moving. More specifically, more and more scientists prefer to use the comb drives for electrostatic actuation, capacitive position sensing and frequency turning.1 [3]They have become an inalienable part of many MEMS devices such as accelerometers, gyroscopes, and micro scanners and so forth.4

However，since it has multiple fingers, the design and optimization of comb drive sensor becomes a challenge for the society. Dr. Xie has already designed and fabricated the out of plane comb drives which can achieve the aim of realizing. 5 And it’s also famous to apply it for designing, some scientists have already successfully designed and tested 1-D analog scanning micromirror arrays with hidden vertical comb-drive actuators.6 And there are also some people using comb drive to solve out sophisticated problems like to overcome the difficulties of isolating two stationary capacitor comb sets in bulk micromachining by the electrically.7 Whereas, those results just lack some visualization, which means the results of them are fixed and hard to show the change of the model.

In this work, I used the new simulate software---COMSOL to make the model more vivid and visual by the moving mesh. The study of the vertical comb-finger actuation for CMOS MEMS is also been realized, simulated and tested, in addition, behavioral simulation using the 3-D NODAS library matches the experimental results within 7% for frequency response.8 Comparing with my work, I do more about the frequency domain to optimize the model which nobody has involved in this filed. I also used fingers to make it parameterized, which can easily change the structure and the parameters of the model. In this way, it can solve the problems that has mentioned above.

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