Abstract

Role of ZnO piezoelectric material in the development of MEMS acoustic sensor for high sound pressure measurement

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Zinc oxide (ZnO) film has played an important role in the field of energy materials due to its piezoelectric and dielectric properties. The films have been widely used in the development of various MEMS devices such as film-bulk acoustic-wave-resonators, surface-acoustic-wave resonators, and acoustic sensors [1]. In the present work, a MEMS acoustic sensor for high sound pressure level measurement has been developed using ZnO as a piezoelectric layer. In the device structure, RF-sputtered ZnO layer is sandwiched between two aluminum electrodes covered with thin PECVD silicon dioxide layers on a thin silicon diaphragm. The silicon diaphragm is created by bulk-micromachining of silicon using TMAH solution. In order to achieve maximum sensitivity of the sensor, one capacitor is fabricated on center area of the diaphragm whereas the other capacitor is fabricated on the outer area of the diaphragm. The sensor responses such as high sound pressure level measurements, bandwidth and sensitivity are measured and found to be 120 dB to 180 dB, 30 Hz to 8 kHz and 380 μV/Pa respectively [2]. A microtunnel, which relates the cavity of structure to atmosphere, is fabricated for pressure compensation. The lower cut-off frequency of the device depends on microtunnel dimensions. Also, the long-term effects of relative humidity on capacitance and dissipation factor tan δ both were studied in different conditions of etched ZnO layer. It was observed that the capacitance values were higher than the original values in the case of strong wet etchants. The corresponding loss tan δ was also increased. However, in similar conditions, the capacitance values did not change in case of weak wet etchant. The results showed that the humidity affects the quality of ZnO layer and finally the performance of device in case of non-step coverage of structure. However, it does not affect performance of device in case of proper step coverage of ZnO layer [3].

References:

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