DESIGN AND FABRICATION OF AN SURFACE ACOUSTIC WAVE SENSOR FOR GREENHOUSE GAS EMISSION MONITORING

Bucur Raul Alin, Farkas Iuliana

National Institute for Research and Development in Electrochemistry and Condensed Matter, Condensed Matter Department, No. 1 Plautius Andronescu, 300224 Timisoara, Romania.
e-mail: raul_alin_bucur@yahoo.com

Abstract

Surface acoustic wave sensors (SAW) are a type of microelectromechanical systems (MEMS) that relies on the modulation of an acoustic wave produced at the surface of piezoelectric material, correlated to a particular restrain applied onto that surface. From a technical point of view, a SAW resonator consists of a pair of micrometer comb-like metallic electrodes, aligned face to face. Also called interdigital transducers (IDT), this pair of electrodes form a resonant cavity. Using a radio frequency input signal applied to one of the electrodes, and taking into consideration the direct piezoelectric effect, this signal will generate onto the second electrode by inverse piezoelectric effect, an electric charge, that can be analyzed in terms of radio frequency output signal, relative to the input signal. The resonant frequency of the device can be tailored simply by remodeling the geometry of the interdigital pins, in terms of overall dimensions, aperture and pin spacing. The sensitivity of the SAW device is related to changes in the velocity of the surface acoustic wave traveling between IDT, as a response to a particular physical phenomenon produced on that surface. Changes in frequency, amplitude, phase, or time-delay between the input and output IDT are used to quantify the presence of the physical phenomenon. Due to their high sensitivity, tunable specificity and small size, SAW sensors can be successfully used for applications such as gas, temperature, mass, pressure, humidity or biological sensors [1, 2]. Considering the possibility of detecting small quantities of gases (ppb) and their ability to operate in "wireless" mode due to the working frequencies (MHz to GHz), the SAW based gas sensors have attracted much interest lately [3; 4].

This paper focuses on the studying of different geometrical alteration of IDT pins and wave reflectors, correlated to the frequency and output signal amplitude shift of a SAW sensor. The silver delay lines were obtained by photolithography onto a piezoelectric substrate, through the negative photo-resist method. The piezoelectric substrate was prior coated with a thick layer of silver, using thermal evaporation with Emitech K975X thermal evaporator. A thin film of UV photosensitive coating was form onto the piezoelectric substrate, using the spin coating technique. The desired IDT image was obtained by Kohler illumination, using a LEVENHUK microscope coupled to a LEVENHUK D740T 5.1M video camera. Finally, the resonant frequency shift and changes in signal level of the SAW device, in the absence and presence of the contaminant, was studied using the RIGOL DSA832 spectrum analyzer.

References

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