ABSTRACT

Micro Electro Mechanical Systems (MEMS) is an egressing field in this era and MEMS possess various applications in the field of Automotive electronics, Communication, Biomedical, Chemical and Sensor. MEMS technology can be defined as miniaturised mechanical and electro-mechanical elements that are made using microfabrication. MEMS and Bio-MEMS are attractive and beneficial area of research, but product development using fabrication technique is very expensive. For successful fabrication of MEMS sensors/ devices, failures occurring in the design process have to be minimised. By reducing the failures, reliability of the design can be enhanced. This research work focuses on the design and simulation of reliable sensors and apply it to two typical applications namely Antigen Detection System (ADS) and microheater design to detect ethanol gas. Modelling of MEMS sensor are investigated and their design optimisation and material selection are discussed.

New sensor design for Antigen detection system for antigen and antibody interaction using cantilever array sensor is designed, investigated and their response compared to other viable tests is evaluated through simulations. In order to avoid the reliability problems such as stiction, fracture four different materials were chosen and simulated Material gold is selected for cantilever that alleviates the reliability and immobilisation problems. More over to avoid the structural instability a tripod structure with different aspect dimension is simulated. Different interspacing between the cantilever and boundary to hold the cantilever is simulated to choose an optimum spacing and boundary. Simulations of effective antigen detection system is developed with heterogenous modular redundancy is carried out using COMSOL multiphysics.

Microheaters were employed to elevate the temperature of the interdigitated sensing layer to increase the gas molecule entrapment which may result into effective sensing. Optimisations of microheater design and microheater materials are done for better temperature uniformity over the sensing layer. The proposed microheater can operate from 200 ^{o}C to 900 ^{o}C. Two main reliability issues faced by the microheater is electromigration and current density issues leading to skin effect. To ameliorate the existing problems, four materials (2 metals and 2 polymer materials) are selected and their conductance characteristics are studied. In order to avoid electromigration a square shaped double spiral microheater structure is proposed which enhances the temperature uniformity of the sensing layer for effective sensing. The key advantage of usage of polymer material is the complete removal of skin effect, as skin effect is caused due to higher current density. To outwit current density issues, polymer materials were investigated for both low temperature and high temperature operation. In polymers current density is caused only by the intrinsic mobility of charge carriers which is very meagre in amount. Higher the current density then higher is the chance of skin effect. The simulations are carried out in COMSOL Multiphysics and Intellisuite