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Magneto-Mechanical MEMS Sensors for Bio-Detection

MariAnne Sullivan and Barton C. Prorok
Auburn University Detection and Food Safety Center
275 Wilmore Lab, Auburn AL 36849-5341

Food safety has become an important issue in the past decade after numerous intentional and unintentional contaminations. With the innovation in science and technology, there has been a remarkable increase in the development of biological weapons throughout the world. Biological agents are considered to be psychologically threatening and therefore provide more appeal to the terrorist. The human pathogenic limit of many engineered biological agents have been reduced in order of magnitude from 10^{15} to few cells. This has led to more research on developing biological agents' detection techniques that are very rapid, sensitive and cost effective. Magnetostrictive materials developed into mass-based acoustic wave Sensor operated on longitudinal vibration mode is one such technique. Magnetostrictive materials are soft amorphous ferromagnetic materials that change in magnetic properties when stress is applied or vice versa. These magnetostrictive materials are fashioned into acoustic wave sensors in the form of simple rectangular strips that are actuated in their longitudinal vibration mode when exposed to magnetic field. Due to the applied field the strips resonate at a specific frequency which is dependent on their mass and physical dimensions. These devices operate similar to magnetostrictive strips used in stores as a surveillance device to prevent the theft of goods.

This magneto-mechanical coupling enables magnetoelastic sensors to be driven to resonance via a modulated magnetic field to detect biological species via frequency shift by mass addition. This work details the development of an algorithm to predict the number of captured *E. coli* cells based only upon the resonance frequency shift. This is an important issue as attaching cells influence resonance based upon their location on the sensor. It is therefore necessary to develop a statistical protocol to predict the concentration of the target agent present.

A Model developed based on the acoustic response of Magnetostrictive Sensor actuated longitudinally with the modulated magnetic field. Numerical simulations and experimental verifications were carried out with the predicted model considering the factors influencing the resonance behavior of the sensor. The tolerance limit of frequency shift corresponding to the distribution of mass, discrete position of the mass attached and the physical dimensions of the sensor platform were determined in several ways. A Good agreement was found between these results offering a good paradigm for detecting biological agents.