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Thin film bulk acoustic resonator biosensors with femtogram mass sensitivity

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Abstract

Over the last decade there has been an increased interest in developing sensitive chemical and biological sensors for early diagnosis of diseases and genetic disorders through detection of associated molecules such as DNA, proteins and peptide aptamers.

Film bulk acoustic wave resonators (FBARs) have been shown to improve the sensitivity and detection limitation compared to other existing technologies, with the possibility of integrating an array of FBARs into existing electronics for control and data processing. However to date the usefulness of these sensors is limited to laboratories where environmental conditions, that are known to have an effect on the response of the sensors, can be tightly controlled.

In this work, novel FBARs exhibiting two modes of resonance are presented. These resonance modes have been designed to exhibit opposite reactions to mass loadings and temperature variations, hence one single device holds information on whether any observed response is due to mass load, temperature change, or a combination of both, avoiding undesirable false responses. In addition, the utilisation of some nanomaterials such as carbon nanotubes as electrodes for the devices will be shown to increase significantly the mass sensitivity due to the greater surface to volume ratio of these materials compared to standard metallic electrodes. In particular, we have, for the first time, fabricated FBARs capable of detecting temperature variations (with sensitivities of ±0.01°C) in parallel with mass loadings (with sensitivities of $\pm 10^{-15}$g), and have demonstrated the suitability of these sensors for the detection of a number of targeted biological systems such as antigen/antibodies, proteins and DNA.

Biography

Andrew J. Flewitt received the B.Sc. degree in physics from the University of Birmingham, Birmingham, U.K., in 1994 and the Ph.D. degree in scanning tunneling microscopy of amorphous silicon from the University of Cambridge, Cambridge, U.K., in 1998. Following this, he was a Research Associate studying the low-temperature growth of silicon-based materials in the Engineering Department, University of Cambridge. He was appointed to a Lectureship in the same Department in 2002. Since 2009, he has held the position of University Reader in Electronic Engineering. His research interests span a broad range of large area electronics and related fields, including thin film transistors and MEMS devices. Dr. Flewitt is a Chartered Engineer and Chartered Physicist, and is a Member of the Institute of Physics and the Institution of Engineering and Technology.