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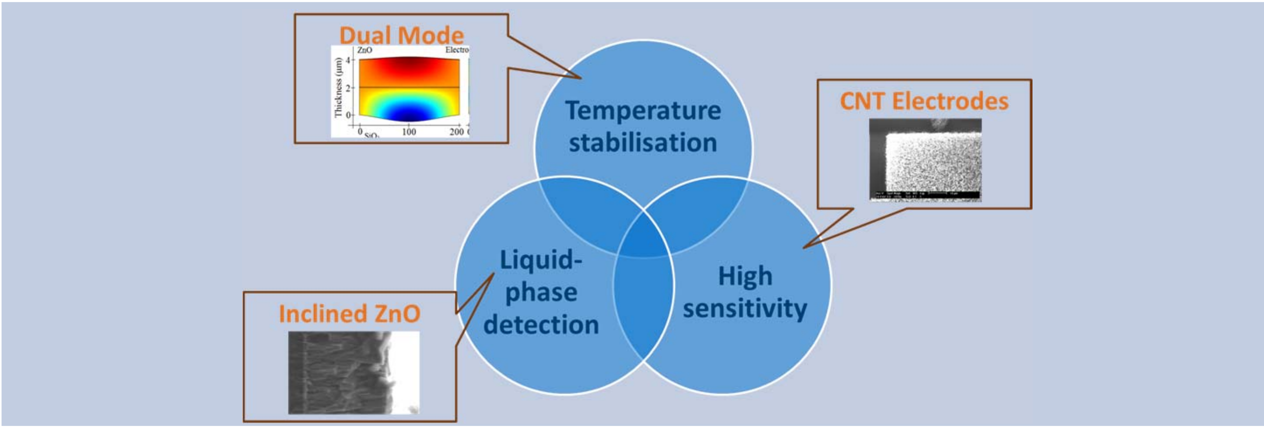
FBAR Sensor

The Portable Mass Sensor for Gas and Biological Sensing



Researchers at the University of Cambridge have developed a novel Film Bulk Acoustic Resonator (FBAR) device which enables the simultaneous measurement of temperature and mass loading in a single device without increasing the size or adding complexity to the electronics. Through the use of a novel multi-layer device structure and carbon nanotube (CNT) electrode materials, temperature self-referenced FBAR resonators with high operating frequencies (~1-2 GHz) and world-leading Q-factors (>1500 in air) have been produced paving the way for real-world monitoring using FBAR sensors. The sensors operate in both air and liquid environments and standard functionalisation chemistry allows selective sensing.

Benefits and applications:

- Selectivity demonstrated
- Suitable for multiplexing for multiple analyte monitoring
- Liquid and gas phase sensing
- Small size (~150×150μm)
- Ultrahigh sensitivity (~10^{-15} g)
- Tuneable frequency of operation (suitable for >0.5 – 3 GHz applications)
- Low power consumption (μW)
- No environmental control required

Lead Inventor:

Andrew Flewitt received a Ph.D. degree in scanning tunnelling microscopy of amorphous silicon from the University of Cambridge in 1998. His research interests span a broad range of large area electronics and related fields, including thin film transistors and MEMS devices.

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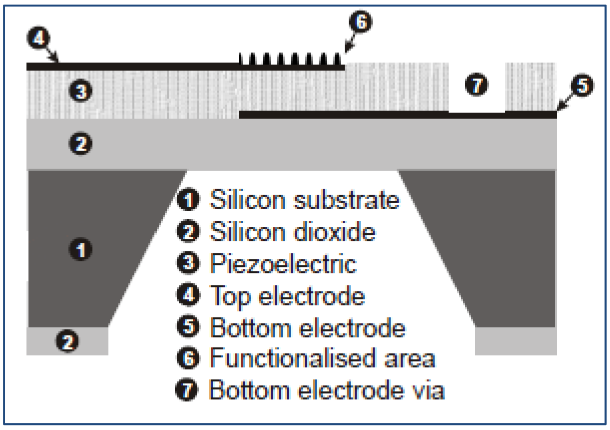
Background

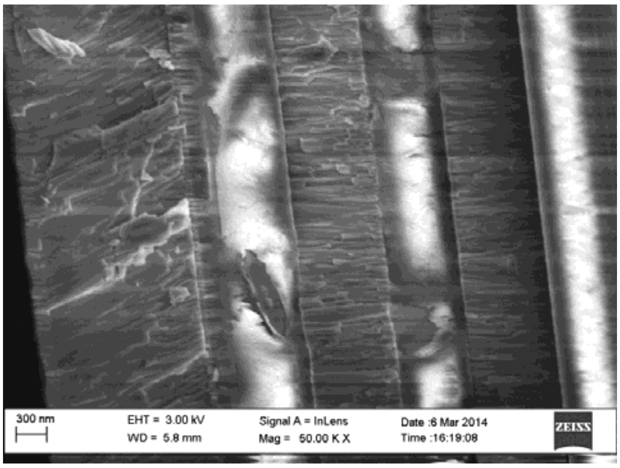
Over the last decade there has been an increased interest in developing high frequency (~GHz range) bulk acoustic wave (BAW) resonators for their development as gravimetric sensors. These devices consist of a piezoelectric layer sandwiched between two metal electrodes to which microwave (RF) signal is applied. Standing acoustic waves with a well defined resonant frequency, f_r, are generated by the rf signal due to the inverse piezoelectric effect. Addition of a mass on the surface of the resonator results in a change in f_r. By tracking changes in f_r , mass changes on the resonators can be detected. One of the most important issues that prevent the commercialization and widespread use of these devices is the frequency shift over temperature, resulting in undesirable false-positive/negative responses, and the suppression of resonance in liquids leading to low sensitivity.

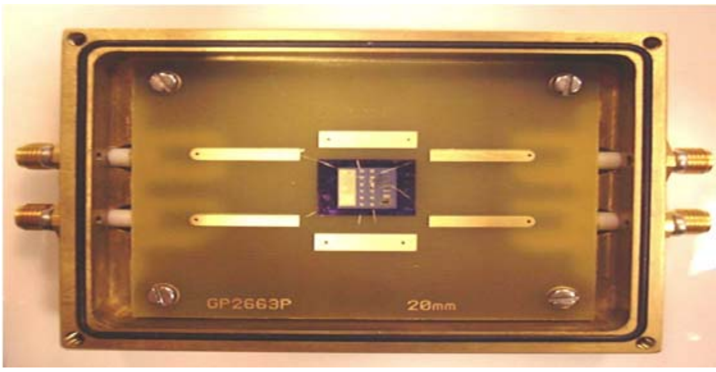
Technology

Resonators designed to support two different fundamental resonant modes at different frequencies have been developed. These resonant modes can be tailored to react differently to external environmental conditions. By careful design of the resonator's structure any observed frequency shift of the fundamental modes can be deconvolved, thereby allowing parallel sensing within the same unit sensor. Control of the piezoelectric microstructure allows a resonance to be produced that is not significantly affected by a liquid on the surface.

Features	Cantilevers	FBAR
Area [m^2]	10^{-7}	10^{-8}
Min Δm [g]	10^{-10}	10^{-15}
Portable	Yes	Yes
Cost	Low	Low
Multiplexing	Yes	Yes







Commercialisation

We are seeking commercial partners for collaborative development and licensing of this technology. The technology is protected by patent application No. GB 1121660.3.

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