Magnetically-Excited Flexural Plate Wave Device

Multifunctional nature of the flexural plate wave sensor enables miniature, self-contained chemical analysis systems

Magnetically-excited flexural plate wave (mag-FPW) devices recently invented at Sandia show potential for filling many necessary functions in a complete miniature chemical analysis system such as that depicted in Figure 1:

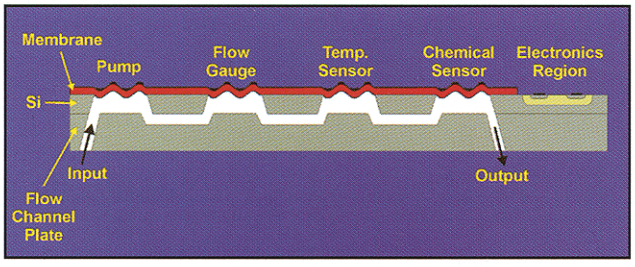

Figure 1. Schematic representation of a complete chemical analysis system based on mag-FPW devices.

- Compatible with both gaseous and liquid analytes.
- Chemical sensitivity through the use of polymer films which selectively absorb the analyte of interest.
- Sensitivity to important physical properties such as temperature and pressure.
- Can be used to pump fluids and gases.
- Isolation of the transducer and electronics from the analyte.
- Low frequency operation (< 1MHz) simplifies the drive electronics and integration.
- No piezoelectric thin film.

Technical Approach

First generation mag-FPW resonators (Figure 2) have already been developed, fabricated, tested, and modeled. These devices were processed using bulk silicon micromachining techniques to produce acoustic transducers suspended on low-stress silicon nitride membranes clamped within a silicon frame. The conceptual drawing of Figure 3 illustrates the magnetic actuation mechanism that is achieved via Lorentz forces generated between an impressed alternating current in a serpentine transducer and a static, in-plane magnetic field. The required magnetic field can be produced by a small permanent magnet (« 1 cm3).

Figure 2. A photograph of first generation mag-FPW devices based on low-stress silicon-nitride membranes.

Coupling strength can be tuned via the magnetic field or the drive current. Magnetic actuation eliminates the need for high-quality piezoelectric thin-films (e.g., ZnO, AlN, or Pb-Ti

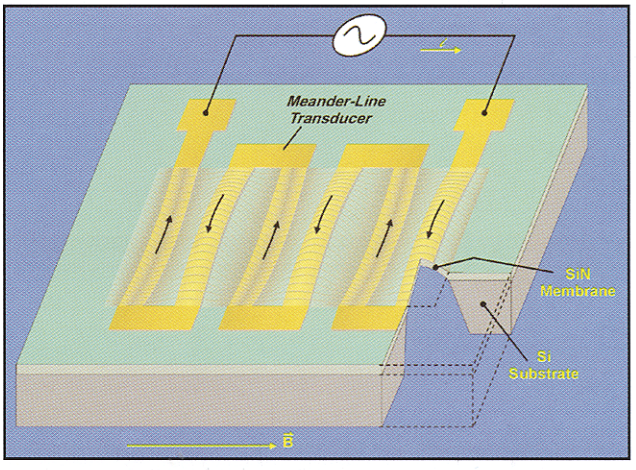

Figure 3. Schematic representation of the mag-FPM resonator.

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materials) normally used in FPW devices, which are difficult to deposit and integrate with silicon microelectronic processing. Electrical breakdown across thin piezoelectric films also limits oscillation amplitudes, an important consideration in pumping applications. Because it does not rely on high electric fields, magnetic actuation eliminates this barrier.

Current efforts in this program are directed at process refinement and design optimization for chemical and physical sensing applications and for pumping operations. Appropriate oscillator designs to implement these functions in a miniature, low-power system are under development, and work is proceeding with respect to integration of the devices with control electronics.

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