481b Millimeter-Sized Mageto-Elastic (Msme) Sensors for Bioterrorism Agent Detection

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Amorphous ferromagnetic ribbons iron-rich alloy ribbons (Fe40Ni38Mo4B18, Metglas 2826) have a high mechanical tensile strength (~1000-1700 MPa), and a high magnetoelastic coupling coefficient (~ 0.98) and magnetostriction on the order of 10^-5. The high magnetoelastic coupling enables efficient conversion between magnetic and elastic energies, and when excited by a sinusoidal magnetic field, the large magnetostriction results in a pronounced magnetoelastic resonance. The resonance frequency depends on the length of the ribbon and in effect its mass.

Sensors of varying length and width (3 to 5 mm x 10 to 20 mm) were Au-coated, annealed for immobilizing antibodies. Protein G was immobilized using the naturally present sulfur groups on the protein. Subsequently, antibody to E coli 0157:H7 (EC) or Bacillus anthracis (Sterne strain, 7702; BA) was attached via Fc region. Cells in the concentration range of 10^2 to 10^6 were exposed in a flow cell at 2 mL/min. The resulting resonance frequency change was monitored using an impedance analyzer and a specially constructed coil under a magnetic bias varying from 6 to 18 Gauss. Initial studies indicate that BA spores at 10^5 spores/mL with a 20 mm long x 5 mm wide sensor showed a 400 Hz decrease in resonance frequency. The resonance was followed by measuring impedance of the coil that encases the flow cell containing the ferromagnetic strip. Measurements were also made using an excitation-pickup coil configuration using a lock-in amplifier. Comparison of the two measurement modalities indicate that impedance technique to be superior and far more stable with a higher signal-to-noise ratio. Current experimental effort is focused on establishing the sensitivity limit for the two pathogens noted above.

We will present results on measurement methodology, flow cell design and the effect of sensor size on resonance frequency, and mass change sensitivity.