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Tuning Fork Sensing Technologies

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Invention Description

The ability to quickly and reliably detect minute changes in environmental conditions, including the presence of chemical, biological or other physical threats within a low-cost, miniaturized package would have broad impact across a variety of application. The presence or absence of specific chemicals and toxic gases in air, harmful compounds in foods and water, and early alert of trace amounts of explosives or chemical and biological warfare agents all require reliable and sensitive detection technologies.

Researchers at the Biodesign Institute of Arizona State University have developed a miniaturized device for sensing a variety of chemical, biological and physical phenomenon based on a common tuning fork technology. The sensor consists of an array of microfabricated quartz tuning fork based sensing elements. Each sensor uses a polymer wire stretched across the two prongs of a tuning fork or simply a polymer-coated tuning fork. Interaction of a chemical or biological analyte with the polymer causes stretching and compressing forces in the wire, which is detected by the quartz tuning fork with pN force sensitivity. The polymer may also absorb energy from radiation or convection. Using the tuning fork sensors, ASU scientists have successfully detected many chemical and biological analytes, and have more recently demonstrated its utility as a thermal/IR sensor.

Potential Applications

- Environmental/health hazards detector – air pollutants, noxious and dangerous chemicals (e.g. formaldehyde), gas leaks, food analysis (spoilage)
- Infrared/thermal detection or imaging
- Environmental conditions sensor – able to sense small changes in temperature and other environmental conditions
- Chemical weapons detector – homeland security issues
- Breath analysis – alcohol, disease biomarkers, such as, nitric oxide for asthma diagnosis and drug dose setting; ketones for management of diabetes; bacterial infections; etc.

Benefits and Advantages

- High sensitivity – the symmetric arrangement of the two prong leads to sharp resonance and differential amplification
- High thermal and mechanical stability - microfabricated quartz tuning forks have near zero thermal coefficient and rigid structure
- Tunable specificity – specificity is achieved by tuning the chemical compositions of the polymers
- Fast response – the response time of the detector is as fast as ms
- Cost effective, portable device - low cost, microfabricated quartz tuning fork technology with simple circuit topology